Lloyd's Register

# Rules and Regulations for the Classification of Ships, July 2012

## Notice No. 1

Effective Date of Latest Amendments:

*See* page 1

Issue date: July 2012

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# RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, *July 2012*

## Notice No. 1

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Ships, July 2012.* The amendments are effective on the dates shown:

| ***Part*** | ***Chapter*** | ***Section*** | ***Effective date*** |
|---|---|---|---|
| 3 | 3 | 5 | 1 July 2012 |
| 3 | 9 | 2 | 1 July 2012 |
| 3 | 11 | 1, 2, 3, 4, 5 | 1 July 2012 |
| 4 | 7 | 12, 13 | 1 July 2012 |
| 4 | 8 | 10, 11 | 1 July 2012 |
| 4 | 11 | 4 | 1 July 2012 |

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Ships, July 2012* are to be read in conjunction with this Notice No. 1. The status of the Rules is now:

| | | |
|---|---|---|
| Rules for Ships | Effective date: | July 2012 |
| Notice No. 1 | Effective date: | 1 July 2012 |

# Part 3, Chapter 3
## Structural Design

**Effective date 1 July, 2012**

■ *Section 5*
## Design loading

### 5.1 General

**Table 3.5.1 Design heads and permissible cargo loadings (SI units)** (*see continuation*) (*Part only shown*)

| Structural item and position | Component | Standard stowage rate $C$, in m$^3$/tonne | Design loading $p$, in kN/m$^2$ | Equivalent design head $h_i$ in metres | Permissible cargo loading in kN/m$^2$ | Equivalent permissible head, in metres |
|---|---|---|---|---|---|---|
| Superstructure decks (Note ~~3~~ 2) | | | | $h_3$ | | |
| ~~Weather deck hatch covers (non-liquid cargo)~~ | ~~*see also* Pt 3, Ch 11, for weather loading~~ | | | ~~$h_H$~~ | | |
| ~~Steel covers – Position 1 (Note 4)~~ | ~~Webs, stiffeners and plating~~ | ~~1,39~~ | ~~$\left(7{,}56 + \frac{L_L}{10{,}26}\right)$~~<br>~~Min. 10,59~~<br>~~Max. 17,17~~ | ~~$\left(1{,}07 + \frac{L_L}{72{,}5}\right)$~~<br>~~Min. 1,5~~<br>~~Max. 2,45~~ | ~~10,59 (Note 2)~~ | ~~1,5 (Note 2)~~ |
| ~~Steel covers – Position 2 (Note 4)~~ | | | ~~$\left(5{,}65 + \frac{L_L}{14{,}15}\right)$~~<br>~~Min. 8,47~~<br>~~Max. 12,77~~ | ~~$\left(0{,}8 + \frac{L_L}{100}\right)$~~<br>~~Min. 1,2~~<br>~~Max. 1,8~~ | ~~8,5 (Note 2)~~ | ~~1,2 (Note 2)~~ |
| ~~Wood covers~~ | ~~As for steel covers~~ | | | | | |

NOTES
1. In the case of beams and longitudinals, the equivalent design head is to be used in conjunction with the appropriate formulae.
~~2. Where the scantlings of weather deck covers have been approved for the loading equal to or in excess of the minimum design loading and cargo is to be carried at this loading, the scantlings of the deck supporting structure are also to be suitable for this loading.~~
~~3.~~2. For forecastle decks forward of 0,12$L$ from F.P., *see* Weather decks.
~~4. For definitions of Positions 1 and 2, and specified cargo loading, *see* Ch 11,1.1.~~
3. For hatch covers of non-CSR bulk carriers, ore carriers and combination carriers, *see* Pt 4, Ch 7,12.
4. For hatch covers of ship types excluding non-CSR bulk carriers, ore carriers and combination carriers, *see* Ch 11,2.
5. For pontoon hatch covers, *see* Ch 11,2.17.

**Table 3.5.1** **Design heads and permissible cargo loadings (metric units)** (*see continuation*) (*Part only shown*)

| Structural item and position | Component | Standard stowage rate $C$, in $m^3$/tonne | Design loading $p$, in tonne-f/$m^2$ | Equivalent design head $h_i$ in metres | Permissible cargo loading in tonne-f/$m^2$ | Equivalent permissible head, in metres |
|---|---|---|---|---|---|---|
| Superstructure decks (Note ~~3~~ 2) | | | | $h_3$ | | |
| ~~Weather deck hatch covers (non-liquid cargo)~~ | ~~*see also* Pt 3, Ch 11, for weather loading~~ | | | ~~$h_H$~~ | | |
| ~~Steel covers – Position 1 (Note 4)~~ | ~~Webs, stiffeners and plating~~ | ~~1,39~~ | ~~$\left(0{,}77 + \frac{L_L}{100{,}8}\right)$~~<br>~~Min. 1,08~~<br>~~Max. 1,75~~ | ~~$\left(0{,}07 + \frac{L_L}{72{,}5}\right)$~~<br>~~Min. 1,5~~<br>~~Max. 2,45~~ | ~~1,08 (Note 2)~~ | ~~1,5 (Note 2)~~ |
| ~~Steel covers – Position 2 (Note 4)~~ | | | ~~$\left(0{,}575 + \frac{L_L}{139}\right)$~~<br>~~Min. 0,865~~<br>~~Max. 1,3~~ | ~~$\left(0{,}8 + \frac{L_L}{100}\right)$~~<br>~~Min. 1,2~~<br>~~Max. 1,8~~ | ~~0,865 (Note 2)~~ | ~~1,2 (Note 2)~~ |
| ~~Wood covers~~ | ~~As for steel covers~~ | | | | | |

NOTES

1. In the case of beams and longitudinals, the equivalent design head is to be used in conjunction with the appropriate formulae.

~~2. Where the scantlings of weather deck covers have been approved for the loading equal to or in excess of the minimum design loading and cargo is to be carried at this loading, the scantlings of the deck supporting structure are also to be suitable for this loading.~~

~~3.~~2. For forecastle decks forward of 0,12$L$ from F.P., *see* Weather decks.

~~4. For definitions of Positions 1 and 2, and specified cargo loading, *see* Ch 11,1.1.~~

3. For hatch covers of non-CSR bulk carriers, ore carriers and combination carriers, *see* Pt 4, Ch 7,12.
4. For hatch covers of ship types excluding non-CSR bulk carriers, ore carriers and combination carriers, *see* Ch 11,2.
5. For pontoon hatch covers, *see* Ch 11,2.17.

# Part 3, Chapter 9

# Special Features

**Effective date 1 July, 2012**

## ■ *Section 2*
## Timber deck cargoes

### 2.7 Scantlings of hatch covers

~~*2.7.1* The section modulus and moment of inertia of hatch cover webs and stiffeners determined from Pt 3, Ch 11 are to be multiplied by the factor~~ $\cancel{\frac{1{,}39h}{h_{\mathrm{H}}\,C}}$ ~~where~~ $\cancel{h_{\mathrm{H}}}$ ~~is defined in Ch 3,5.1.~~

*2.7.1* The scantlings of primary supporting members and secondary stiffeners are to comply with Ch 11,2.3.4 for distributed cargo load $p_{\mathrm{L}}$ using $p_{\mathrm{C}} = h/C$.

### 2.8 Direct calculations

*2.8.2* In the case of hatch covers, the stress and deflection criteria given in ~~Table 11.2.3 in Chapter 11~~ Ch 11,2.4 corresponding to a uniformly distributed weather load are not to be exceeded.

# Part 3, Chapter 11

# Closing Arrangements for Shell, Deck and Bulkheads

**Effective date 1 July, 2012**

## ■ *Section 1*
## General

### 1.1 Application

*1.1.1* This Chapter applies to all ship types detailed in Part 4, unless otherwise stated, with the exception of Sections 1 to 5 which are not applicable to Bulk Carriers with a **CSR** notation, *see* Pt 1, Ch 2,2.3. Additional provisions regarding access arrangements for oil tankers and chemical carriers are contained in Pt 4, Ch 9, Ch 10 and the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquid Chemicals in Bulk* (hereinafter referred to as the Rules for Ships for Liquid Chemicals), respectively.

(*Part only shown*)
*1.1.5* The type of hatch covers on the weather decks of the basic ship types defined in 1.1.4 are detailed below and may be used in the types of ships as indicated in Table 11.1.1:

(b) Steel plated cargo hatch pontoon covers having interior webs and stiffeners extending for the full width of the hatchway. ~~Weathertightness to be obtained by tarpaulins.~~ A pontoon cover is defined as a portable cover, secured weathertight by tarpaulins and battening devices.

*1.1.8* The scantlings specified in the following Sections are applicable to covers of mild steel or higher tensile steel. Where other materials are used, equivalent scantlings are to be provided. The scantlings apply basically to rectangular covers, with the stiffening members arranged primarily in one direction and carrying a uniformly distributed load. The covers are assumed to be simply supported. Where covers are stiffened by a grillage formation, and also where point loads are applied to any type of cover, the scantlings are to be determined from direct calculations~~, see 2.2.4~~.

*1.1.10* The scantlings of hatch covers need to be increased only if the ~~maximum~~ loading exceeds ~~17,17 kN/m²~~ that given in 2.3. The scantlings of the surrounding deck structure are to be sufficient to support this loading. Heavier loading may be permitted only if the scantlings of the cover ~~are increased in direct proportion to the load~~ are capable of withstanding this increased loading, satisfying the stress and deflection criteria given in this Chapter. The deck structure is also to be capable of withstanding this increased loading.

*1.1.11* Where timber cargo is to be carried on the hatch covers the requirements of Ch 9,2.7 are to be satisfied in addition to the requirements of this Chapter.

*1.1.13* The net plate thickness, $t_{\mathrm{net}}$, is the calculated minimum thickness of the plating and stiffeners. The required thickness is the net thickness plus a corrosion addition, $t_{\mathrm{c}}$, given in Table 11.1.2.

~~**Table 11.1.2 Corrosion addition**~~ ~~$t_{\mathrm{c}}$~~

| Hatch cover type | $t_{\mathrm{c}}$, in mm |
|---|---|
| (a) Single skin | 2,0 |
| (b) Pontoon (double skin) | |
| (i) for the top and bottom plating | 2,0 |
| (ii) for the internal structures | 1,5 |
| For coaming and coaming stays | 1,5 |

**Table 11.1.2 Corrosion addition $t_c$**

| Application | Structure | $t_c$, in mm |
|---|---|---|
| Weather deck hatches of container ships, car carriers, paper carriers, passenger vessels | Hatch covers | 1,0 |
| | Hatch coamings | 1,0 |
| Weather deck hatches of all other ship types except bulk carriers, ore carriers and combination carriers, *see* Pt 4, Ch 7,12.1.2 | Hatch covers in general | 2,0 |
| | Weather exposed plating and bottom plating of double skin hatch covers | 1,5 |
| | Internal structure of double skin hatch covers and closed box girders | 1,0 |
| | Hatch coamings | 1,5 |
| | Coaming stays and stiffeners | 1,5 |
| 'Tween deck hatches | Hatch covers in general | 1,0 |

*1.1.14* For ships with cargo environments giving permanently reduced corrosion characteristics and with increased protection of hatch covers from excessive freeboard height above the freeboard, or virtual freeboard deck, the corrosion margin may be specially considered.

## 1.2 Symbols

*1.2.1* The minimum design pressure, $p$, in kN/m$^2$, acting on the hatch covers is given by:

(a) For ships of length 100 m or greater, for hatchways located at the freeboard deck, $p$ is to be the greater of 34,3 or the following:

$$p = 34{,}3 + \frac{p_{FP} - 34{,}3}{0{,}25}\left(0{,}25 - \frac{x}{L_L}\right) \text{ kN/m}^2$$

Where a hatchway is located in the forward quarter of the Load Line length and at least one standard superstructure height higher than the freeboard deck, the pressure $p$ may be 34,3 kN/m$^2$. Position 2 hatch covers are to be designed with $p$ taken as 25,5 kN/m$^2$.

(b) For ships less than 100 m in length, for hatchways located at the freeboard deck, $p$ is to be the greater of $0{,}195L_L + 14{,}9$ or the following:

$$p = 15{,}8 + \frac{L_L}{3}\left(1 - \frac{5}{3}\frac{x}{L}\right) - 3{,}6\frac{x}{L_L} \text{ kN/m}^2$$

Where two or more panels are connected by hinges, each individual panel is to be considered separately. Position 2 hatch covers are to be designed with $p$ taken as 14,7 kN/m$^2$ where $L_L$ is 24 m and $p$ taken as 25,5 kN/m$^2$ where $L_L$ is 100 m; intermediate values are to be obtained by linear interpolation.

where

$p_{FP}$ = pressure at the forward perpendicular.
= $49{,}1 + (L_L - 100)\,a$
$a$ = 0,0726 for type B freeboard ships
= 0,356 for ships with reduced freeboard
$L_L$ = freeboard length, in metres, as defined in the Load Lines Conventions, to be taken not greater than 340 m
$x$ = distance, in metres, of the mid length of the hatch cover under examination from the forward end of $L_L$.

(c) For weather deck covers for holds which may be flooded and used as ballast tanks and holds in OBO, ore or oil and similar types of ship, the pressure for the internal load is to be taken as that corresponding to the ship heeled to 25° with the liquid level in the hold intersecting the hatch cover top line at the centreline of the ship.

The pressure $p$, in kN/m$^2$ for the member and position under consideration is not to be less than $4{,}14Y_s$ where

$Y_s$ = is to be taken as the distance from ship centreline to the edge, stiffener, or primary member under consideration, in metres.

In way of holds for oil cargo, a load equivalent to the inert gas pressure is to be applied over the full breadth of the cover and added to the load corresponding to the liquid pressure.

The above pressures are to be applied in conjunction with a stowage rate of 0,975 m$^3$/tonne.

However, where the rolling angle has been determined by direct calculations, the load may be derived accordingly, but is not to be less than that required in (a).

(d) In 'tween decks:

$p$ = is to be taken as the 'tween deck height, in metres, measured vertically on the centreline of the ship from 'tween deck to underside of hatch cover stiffeners on deck above, multiplied by a factor of 7,06

For specified rates of loading in excess of 1,39 m$^3$/tonne, an equivalent $p$ is to be used.

In accommodation spaces, $p$ is to be taken as 12,7 kN/m$^2$.

*1.2.2* The following symbols and definitions, in addition to those given in 1.2.1, are applicable to this Chapter, unless otherwise stated:

(a) $L$, $L_L$ as defined in Ch 1,6.1.

(b) The following definitions apply to webs or stiffeners with attached plating, or portable beams:

$b$ = length of panel (longer panel dimension), in mm, in transverse direction, *see* Fig. 11.1.1
$d_w$ = overall depth at the supports, measured as shown in Fig. 11.1.2, but is to be not less than 150 mm, *see also* definition of $l_1$
$k$ = higher tensile steel factor, *see* Ch 2,1.2
$l_0$ = unsupported span, in metres, measured as shown in Fig. 11.1.2
$l_1$ = proportion of the span, in metres, measured as shown in Fig. 11.1.2. The depth and face area over the remainder of the span is assumed to be constant
$s$ = spacing of webs and stiffeners (shorter panel dimension), in mm
$t$ = thickness of plating, in mm
$H_c$ = height of hatch coaming, in mm
$\sigma_{ac}$ = corrected critical buckling stress, in N/mm$^2$ (kgf/mm$^2$)
$\sigma_b$ = the compressive bending stress, in N/mm$^2$ (kgf/mm$^2$), in the steel cover plating, calculated by taking the cover as a loaded beam simply supported at its ends

~~$\sigma_c$ = critical buckling stress of panel, in N/mm$^2$ (kgf/mm$^2$)~~
~~$\sigma_o$ = yield stress of cover plating material, in N/mm$^2$ (kgf/mm$^2$)~~
~~$\sigma_u$ = minimum ultimate tensile strength, in N/mm$^2$ (kgf/mm$^2$).~~
~~$h_H$ = head, as defined in Ch 3,5.1.~~

## Section 2
## Steel hatch covers

### ~~2.1 Plating~~

~~*2.1.1* The thickness of the plating of steel hatch covers is to be not less than required by Table 11.2.1.~~

### ~~2.2 Webs and stiffeners~~

~~*2.2.1* The scantlings of steel cover primary and secondary webs or stiffeners are to be not less than would be required to satisfy the requirements of Table 11.2.2.~~

~~*2.2.2* As an alternative to 2.2.1, scantlings may be determined by direct calculations, which are to be submitted for approval. In no case are the stresses and deflections given in Table 11.2.3 to be exceeded.~~

~~*2.2.3* Where hatch covers are subjected to point loads, such as from containers, the requirements of Pt 4, Ch 8,11 are also to be complied with.~~

~~*2.2.4* Covers having primary stiffeners in two directions will be considered using direct calculations in conjunction with the requirements of Table 11.2.3. For weather deck covers for holds which may be flooded and used as ballast tanks, and holds in OBO, ore or oil and similar types of ship the loading is to be as required by 1.2.1(b) but is not to be less than 1.2.1(a).~~

~~*2.2.5* On ships of length $L_L$ greater than 100 m, hatch covers fitted on top of a second, or virtual second, tier superstructure (as defined in Ch 8,1.3) or above, may be permitted a reduction in design pressure. The following minimum scantlings are to be complied with:~~
~~(a) Abaft 0,25$L_L$ the cover plate thickness may be 0,0091$s$ but not less than 6 mm.~~
~~(b) The value of $p$ used in 1.2.1 may be 25,5 kN/m$^2$ forward of 0,25$L_L$, and 20,6 kN/m$^2$ abaft of 0,25$L_L$.~~

~~*2.2.6* For the omission of gaskets or hatch covers in ships carrying container cargoes, *see* Pt 4, Ch 8,11.~~

### 2.1 General

*2.1.1* The requirements of Section 2 are not applicable to hatch covers of bulk carriers, ore carriers and combination carriers.

*2.1.2* The strength requirements in 2.1 to 2.16 are applicable to hatch covers and closing arrangements of stiffened plate construction. The strength requirements are applicable to exposed weather deck hatch covers and 'tween deck hatch covers, unless otherwise stated.

*2.1.3* Sub-Sections 2.1 to 2.16 are not applicable to portable covers secured weathertight by tarpaulins and battening devices, or pontoon covers, *see* 2.17.

*2.1.4* Unless otherwise stated, the thicknesses referred to in the following Sections are net thicknesses. The net thicknesses are the member thicknesses necessary to obtain the minimum net scantlings required in this Section. The required gross thicknesses are obtained by adding corrosion additions, $t_c$, given in Table 11.1.2. Strength calculations using beam theory, grillage analysis or FEM are to be performed with net scantlings.

*2.1.5* Material class I is to be applied for hatch covers.

*2.1.6* The strength and closing arrangements of hatch covers are to comply with Pt 4, Ch 7,12 in addition to the requirements in this Chapter when hatch covers are subjected to internal ballast or oil cargo pressure.

*2.1.7* Hatch covers are to comply with Pt 4, Ch 8,11 in addition to the requirements in this Chapter when containers are carried on covers.

### 2.2 Stiffener arrangement

*2.2.1* The primary supporting members and secondary stiffeners of hatch covers are to be continuous over the breadth and length of hatch covers, as far as practical. When this is impractical, sniped end connections are not to be used and appropriate arrangements are to be adopted to ensure sufficient load-carrying capacity.

*2.2.2* The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed one third of the span of primary supporting members. When strength calculation is carried out by FE analysis using plane strain or shell elements, this requirement can be waived.

### 2.3 Load model

*2.3.1* The structural assessment of hatch covers is to be carried out using the design loads defined in this Section. The following symbols and definitions are applicable to this Section:

$x$ = longitudinal co-ordinate measured from the AP to mid point of assessed structural member
$T_{fb}$ = draught, in metres, corresponding to the assigned summer load line
$h_N$ = standard superstructure height in metres
= $1{,}05 + 0{,}01L_L, \quad 1{,}8 \le h_N \le 2{,}3$
where
$L_L$ = load line length, as defined in Pt 3, Ch 1,6.1.8.

**~~Table 11.2.1 Steel hatch cover plating~~**

| Symbols | Position of cover | Thickness of cover |
|---|---|---|
| $k$, $s$, $b$ and $t$ as defined in 1.2<br>For $h_H \le 3,5$ m, $K_c = 1$<br>$p \le 34,3$ kN/m$^2$, $K_c = 1,116$<br>For $h_H > 3,5$ m, $K_c = \sqrt[3]{0,286h_H}$<br>$p > 34,3$ kN/m$^2$, $K_c = \sqrt[3]{0,0405p}$<br>$Y$ = distance from ship centreline to the outboard edge of the plate under consideration, in metres | Steel covers to dry cargo holds | The greater of:<br>(a) $t = 0,01sK_c \sqrt{k}$ mm<br>(b) $t = 6,0$ mm |
| | OBO, ore or oil or similar types of ships and weather deck openings to holds which may be flooded and used as ballast tanks | The greatest of:<br>(a) $t = (0,01s + 0,5)\sqrt{k}$ mm<br>(b) $t = (0,0025s\sqrt{Y} + 2,5)\sqrt{k}$ mm<br>(c) $t = 7,5$ mm |
| | 'Tween deck covers to deep tanks | Pt 4, Ch 1,9 for plating forming boundaries of tanks |
| | Covers on decks where wheeled vehicles are used | Ch 9,3 for deck plating where wheeled vehicles are used |
| | Portable covers | The greater of:<br>(a) $t = 0,01s$ mm<br>(b) $t = 3,5$ mm |
| | Reduced thicknesses for covers in certain positions | *See* 2.2.5 |

Buckling requirements for hatch cover plating

$\sigma_b$, $\sigma_c$, $\sigma_{ac}$ and $\sigma_o$ are defined in 1.2

$$\sigma_c = 18,6R_c\left(\frac{t}{b}\right)^2 \times 10^4 \text{ N/mm}^2$$

$$\sigma_{ac} = \sigma_o\left(1 - \frac{\sigma_o}{4\sigma_c}\right) \text{ N/mm}^2 \quad (\text{kgf/mm}^2)$$

$$\left(\sigma_c = 1,9R_c\left(\frac{t}{b}\right)^2 \times 10^4 \text{ kgf/mm}^2\right)$$

(a) Where primary bending stress acts on longer panel edge $b$, *see* Fig. 11.1.1:

$$\frac{\sigma_c}{\sigma_b}\left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \ge 1,3 \qquad \text{where } R_c = \left(\frac{s}{b} + \frac{b}{s}\right)^2$$

Where primary bending stress acts on shorter panel edge $s$:

$$\frac{\sigma_c}{\sigma_b}\left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \ge 1,2 \qquad \text{where } R_c = 4\left(\frac{b^2}{s^2}\right)$$

If $\sigma_c > 0,5\,\sigma_o$ then corrected value $\sigma_{ac}$ is used

It is recommended that $\left(\frac{b}{s}\right) < 5,0$

(b) Where covers are stiffened in two directions by a grillage formation, buckling checks are to be carried out as per (a) above for bending stresses acting on both the longer and shorter edges of the panel.
For the derivation of the section modulus for primary members an effective width of plating to achieve a balanced section is to be adopted. However a greater width of plating in accordance with Ch 3,3.2 may be adopted where this is suitably stiffened in the directions being considered from the buckling aspect.

**~~Table 11.2.2 Steel hatch cover webs and stiffeners~~**

| Symbols | Position of cover | Type of cover | Requirement (primary stiffening) |
|---|---|---|---|
| $I_0$ and $I_1$ are moments of inertia, in cm$^4$, at mid-span and supports, where $I_1 > 0{,}05 I_0$<br>$l_0$, $l_1$ and $h_H$ are defined in 1.2, except that for covers to deep tanks in 'tween decks $h_H = 1{,}67H$, where $H$ is half the vertical height from top of the overflow<br>$C_H = 1 + \frac{8\alpha_H^3 (1 - \beta_H)}{0{,}2 + 3\sqrt{\beta_H}}$<br>$K_H = 1 + \frac{3{,}2\alpha_H - \gamma_H - 0{,}8}{7{,}0\gamma_H + 0{,}4}$<br>but not less than 1,0. To be specially considered when discontinuities in area of face material occur<br>$K_1$ and $C_1$ are given opposite<br>$Z_0$ and $Z_1$ are section moduli, in cm$^3$, at mid-span and supports<br>$\alpha_H = \frac{l_1}{l_0}$ $\beta_H = \frac{I_1}{I_0}$ $\gamma_H = \frac{Z_1}{Z_0}$<br>For weather decks:<br>$F = \frac{400 \text{ N/mm}^2 \text{ (41 kgf/mm}^2\text{)}}{\text{Minimum ultimate tensile strength for higher tensile steel used in manufacture}}$<br>For 'tween decks<br>$F = k$<br>$k$ as defined in 1.2.2 | Weather decks – Positions 1 and 2 | (1)<br>(a) Covers secured by clamping devices<br>(b) Portable covers | $Z_0 = \frac{p\, s\, l_0^2 K_H F}{K_1}$ cm$^3$<br>$I_0 = \frac{p\, s\, l_0^3 C_H}{C_1}$ cm$^4$ |
| | | (2) Covers for holds in OBO, ore or oil or similar types of ships and covers to holds which may be flooded and used as ballast tanks | As for (1)<br>Thickness of webs or stiffeners >7,5 mm |
| | | (3) Pontoon covers | As for (1) |
| | Cargo 'tween decks | (4) Covers including pontoon covers | As for (1)<br>Covers carrying wheeled vehicles are also to comply with Ch 9,3 |
| | Secondary panel stiffening | | |
| | The section modulus and moment of inertia are to be derived as for longitudinal primary stiffening, using appropriate span and spacing. Where the ends of the panel stiffeners are effectively bracketed or continuous, these values of modulus and inertia may be reduced respectively by 33 per cent and 80 per cent | | |

| Type of cover | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $K_1$ | 1507 | 1507 | 1281 | 1865 |
| $C_1$ | 886 | 633 | 696 | 1108 |

**~~Table 11.2.3 Parameters for direct calculations~~**

| Location | Item | Loading | Permissible bending stress N/mm$^2$ (kgf/mm$^2$) | Permissible shear stress N/mm$^2$ (kgf/mm$^2$) | Permissible deflection, metres |
|---|---|---|---|---|---|
| Weather deck – Positions 1 and 2, *see* Note | Steel weather-tight covers | Uniformly distributed (weather load) | $0{,}8\sigma_0$ | $0{,}46\sigma_0$ | $0{,}0056 l_0$ |
| | Steel weather deck covers for holds which may be flooded and used as ballast tanks, and holds in OBO, ore or oil or similar types of ships | Internal loading *See* 1.2.1(b) | $\frac{117{,}7}{k} \left(\frac{12{,}0}{k}\right)$ | $\frac{68{,}7}{k} \left(\frac{7{,}0}{k}\right)$ | $0{,}0020 l_0$ |
| | Pontoon covers | Uniformly distributed (weather load) *See* Ch 3,5 | $0{,}68\sigma_0$ | | $0{,}0044 l_0$ |
| Cargo 'tween deck, *see* Note | Steel covers | Uniformly distributed container or other specified loading | $\frac{117{,}7}{k} \left(\frac{12{,}0}{k}\right)$ | | $0{,}0035 l_0$ |

NOTE

For buckling requirements for hatch cover plating, *see* Table 11.2.1. Alternatively, the criteria in Pt 4, Ch 7,12 may be applied.

*2.3.2* The vertical weather design pressure, $p_H$, in kN/m$^2$, on the hatch cover panels is to be taken from Table 11.2.1. When cargo is carried on the cover, cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2 are to be considered. The vertical weather design load needs not to be combined with the cargo load. For 'tween deck hatch covers not exposed to weather load, the structural assessment is to be carried out using the cargo loads defined in 2.3.4 and 2.3.5. Covers carrying wheeled vehicles are also to comply with Ch 9,3 and where it is proposed to provide a helicopter landing area, covers are also to comply with Ch 9,5. Where an increased freeboard is assigned, the design load for hatch covers according to Table 11.2.1 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance at least equal to the standard superstructure height $h_N$ below the actual freeboard deck.

**Table 11.2.1 Design pressure $p_H$ of weather deck hatches**

| Position | $p_H$, in kN/m$^2$ | |
|---|---|---|
| 1 | $\frac{x}{L_L} \le 0{,}75$ | $0{,}75 < \frac{x}{L_L} \le 1{,}0$ |
| | For 24 m $\le L_L \le$ 100 m | |
| | $\frac{g}{76}(1{,}5L_L + 116)$ | on freeboard deck<br>$\frac{g}{76}\left[(4{,}28L_L + 28)\frac{x}{L_L} - 1{,}71L_L + 95\right]$ |
| | | upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck<br>$\frac{g}{76}(1{,}15L_L + 116)$ |
| | For $L_L$ > 100 m | |
| | $3{,}5g$ | on freeboard deck for type B ships according to ICLL<br>$g\left[(0{,}0296L_1 + 3{,}04)\frac{x}{L_L} - 0{,}0222L_1 + 1{,}22\right]$ |
| | | on freeboard deck for ships with less freeboard than type B according to ICLL<br>$g\left[(0{,}1452L_1 - 8{,}52)\frac{x}{L_L} - 0{,}1089L_1 + 9{,}89\right]$<br>$L_1 = L_L$ but not more than 340 m |
| | | upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck<br>$3{,}5g$ |
| 2 | For 24 m $\le L_L \le$ 100 m | |
| | $\frac{g}{76}(1{,}1L_L + 87{,}6)$ | |
| | For $L_L$ > 100 m | |
| | $2{,}6g$ | |
| | upon exposed superstructure decks located at least one superstructure standard height above the lowest Position 2 deck<br>$2{,}1g$ | |
| Symbols | | |
| $L_L$ = load line length, as defined in Pt 3, Ch 1,6.1.8<br>$g$ = acceleration due to gravity, 9,81 m/s$^2$ | | |

*2.3.3* The horizontal weather design pressure, in kN/m$^2$, for determining the scantlings of outer edge girders (skirt plates) of weather deck hatch covers is:

$$p_A = a\, c\, (b\, c_L\, f - z) \ \text{kN/m}^2$$

$$f = \frac{L}{25} + 4{,}1 \qquad \text{for } L < 90 \text{ m}$$

$$= 10{,}75 - \left(\frac{300 - L}{100}\right)^{1,5} \qquad \text{for } 90 \text{ m} \leq L < 300 \text{ m}$$

$$= 10{,}75 \qquad \text{for } 300 \text{ m} \leq L < 350 \text{ m}$$

$$= 10{,}75 - \left(\frac{L - 350}{150}\right)^{1,5} \qquad \text{for } 350 \text{ m} \leq L \leq 500 \text{ m}$$

$$c_L = \sqrt{\frac{L}{90}} \qquad \text{for } L < 90 \text{ m}$$

$$= 1 \qquad \text{for } L \geq 90 \text{ m}$$

$$a = 20 + \frac{L_1}{12}$$ for unprotected front coamings and hatch cover skirt plates

$$a = 10 + \frac{L_1}{12}$$ for unprotected front coamings and hatch cover skirt plates where the distance from the actual freeboard deck to the summer load line exceeds the minimum non-corrected tabular freeboard according to ICLL by at least one standard superstructure height $h_N$

$$a = 5 + \frac{L_1}{15}$$ for side and protected front coamings and hatch cover skirt plates

$$a = 7 + \frac{L_1}{100} - 8\,\frac{x'}{L}$$ for aft ends of coamings and aft hatch cover skirt plates abaft amidships

$$a = 5 + \frac{L_1}{100} - 4\,\frac{x'}{L}$$ for aft ends of coamings and aft hatch cover skirt plates forward of amidships

$L_1$ = $L$, need not be taken greater than 300 m

$$b = 1{,}0 + \left(\frac{\frac{x'}{L} - 0{,}45}{C_b + 0{,}2}\right)^2 \qquad \text{for } \left(\frac{x'}{L}\right) < 0{,}45$$

$$b = 1{,}0 + 1{,}5\left(\frac{\frac{x'}{L} - 0{,}45}{C_b + 0{,}2}\right)^2 \qquad \text{for } \left(\frac{x'}{L}\right) \geq 0{,}45$$

$0{,}6 \leq C_b \leq 0{,}8$, when determining scantlings of aft ends of coamings and aft hatch cover skirt plates forward of amidships, $C_b$ need not be taken less than 0,8

$C_b$ = block coefficient, as defined in Pt 3, Ch 1,6.1.6

$x'$ = distance, in metres, between the transverse coaming or hatch cover skirt plate considered and aft end of the length $L$. When determining side coamings or side hatch cover skirt plates, the side is to be subdivided into parts of approximately equal length, not exceeding 0,15$L$ each, and $x'$ is to be taken as the distance between aft end of the length $L$ and the centre of each part considered

$z$ = vertical distance in metres from the summer load line to the midpoint of stiffener span, or to the middle of the plate field

$$c = 0{,}3 + 0{,}7\,\frac{b'}{B'}$$

$b'$ = breadth of coaming in metres at the position considered

$B'$ = actual maximum breadth of ship in metres on the exposed weather deck at the position considered

$b'/B'$ is not to be taken less than 0,25

The design pressure $p_A$ is not to be taken less than the minimum values given in Table 11.2.2.

**Table 11.2.2 Minimum design load, $p_{A\min}$**

| $L$ | $P_{A\min}$, kN/m$^2$ | |
|---|---|---|
| | For unprotected fronts | Elsewhere |
| ≤ 50 | 30 | 15 |
| > 50 | $25 + \frac{L}{10}$ | $12{,}5 + \frac{L}{20}$ |
| < 250 | | |
| ≥ 250 | 50 | 25 |

*2.3.4* The pressure on hatch covers due to distributed cargo loads $p_L$, in kN/m$^2$, resulting from heave and pitch, is to be determined according to the following formula:

$$p_L = p_c\,(1 + a_v) \ \text{kN/m}^2$$

where

$p_c$ = uniform cargo load, in kN/m$^2$

NOTE

For 'tween deck hatch covers, $p_c$ is not to be taken less than 7,07 $H_{td}$ kN/m$^2$, *see* Ch 3,5.2.1, Table 3.5.1 and Fig 3.5.1. A design load less than this will be specially considered.

$a_v$ = acceleration addition as follows:

$$a_v = F\,m$$

$$F = 0{,}11\,\frac{v_0}{\sqrt{L}}$$

$$m = m_0 - 5\,(m_0 - 1)\,\frac{x}{L} \qquad \text{for } 0 \leq \frac{x}{L} \leq 0{,}2$$

$$= 1{,}0 \text{ for } 0{,}2 < \frac{x}{L} \leq 0{,}7$$

$$= 1 + \frac{m_0 + 1}{0{,}3}\left(\frac{x}{L} - 0{,}7\right) \qquad \text{for } 0{,}7 < \frac{x}{L} \leq 1{,}0$$

$$m_0 = 1{,}5 + F$$

$v_0$ = max. speed at summer load line draught, $v_0$ is not to be taken less than $\sqrt{L}$, in knots.

*2.3.5* Point loads due to single forces, $P$, in kN, resulting from heave and pitch are to be determined as follows:

$$P = P_s\,(1 + a_v) \ \text{kN}$$

$P_s$ = single force, in kN.

*2.3.6* In addition to the loads defined in this Section, hatch covers are loaded in the ship's transverse direction by forces due to elastic deformations of the ship's hull. Hatch covers are to be designed such that the sum of stresses does not exceed the permissible values given in 2.4.1.

## 2.4 Allowable stress and deflection

*2.4.1* The equivalent stress $\sigma_v$ in steel hatch cover structures related to the net thickness shall not exceed $0{,}8\sigma_o$, where $\sigma_o$ is the minimum yield stress, in N/mm$^2$, of the material. For design loads according to 2.3.3 to 2.3.6 and Pt 4, Ch 8,11.2, the equivalent stress $\sigma_v$ related to the net thickness shall not exceed $0{,}9\sigma_o$ when the stresses are assessed by means of FEM using plane stress or shell elements.

For beam element calculations and grillage analysis, the equivalent stress may be taken as follows:

$$\sigma_v = \sqrt{\sigma^2 + 3\tau^2}\text{ , in N/mm}^2$$

$\sigma$ = normal stress in N/mm$^2$

$\tau$ = shear stress in N/mm$^2$

For FEM calculations, the equivalent stress may be taken as follows:

$$\sigma_v = \sqrt{\sigma_x{}^2 - \sigma_x\sigma_y + \sigma_y{}^2 + 3\tau^2}\text{ , in N/mm}^2$$

$\sigma_x$ = normal stress, in N/mm$^2$, in x-direction

$\sigma_y$ = normal stress, in N/mm$^2$, in y-direction

$\tau$ = shear stress, in N/mm$^2$, in the x-y plane

Indices x and y are coordinates of a two-dimensional Cartesian system in the plane of the considered structural element.

In the case of FEM calculations using shell or plane strain elements, the stresses are to be read from the centre of the individual element. Where shell elements are used, the stresses are to be evaluated at the mid plane of the element. Stress concentrations are to be considered. FEM calculations are to be carried out in accordance with the ShipRight procedure *Assessment of Steel Hatch Covers using Finite Element Analysis*.

*2.4.2* The vertical deflection of primary supporting members due to the vertical weather design load according to 2.3.2, or cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2, is to be not more than $0{,}0056l_g$ where $l_g$ is the greatest span of primary supporting members.

For 'tween deck hatch covers not exposed to the vertical weather design load according to 2.3.2, the vertical deflection of primary supporting members due to the cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2 is to be not more than $0{,}007l_g$ where $l_g$ is the greatest span of primary supporting members.

## 2.5 Local net plate thickness

*2.5.1* The local net plate thickness, $t$, in mm, of the hatch cover top plating is not to be less than:

$$t = F_p\, 0{,}0158s\sqrt{\frac{p}{0{,}95\sigma_o}}$$

and to be not less than 1 per cent of the spacing of the stiffener or 6 mm, whichever is greater

$F_p$ = factor for combined membrane and bending response

= 1,5 in general

$= 1{,}9\,\dfrac{\sigma}{\sigma_a}$, for $\dfrac{\sigma}{\sigma_a} \geq 0{,}8$

for the attached plate flange of primary supporting members

$s$ = stiffener spacing, in mm

$p$ = pressure $p_H$ and $p_L$, in kN/m$^2$, as defined in 2.3

$\sigma$ = normal stress, in N/mm$^2$, of hatch cover top plating

$\sigma_a$ = $0{,}8\sigma_o$, in N/mm$^2$

For flange plates under compression, sufficient buckling strength according to 2.11 is to be demonstrated.

The normal stress $\sigma$ of the hatch cover plating may be determined in a distance $s$ from webs of adjacent primary supporting members perpendicular to secondary stiffeners, and in a distance $s/2$ from the web of an adjacent primary supporting member parallel to secondary stiffeners, *see* Fig. 11.2.1. The greater of both stresses is to be taken. For the distribution of normal stress $\sigma$ between two parallel girders, *see* 2.14.1.

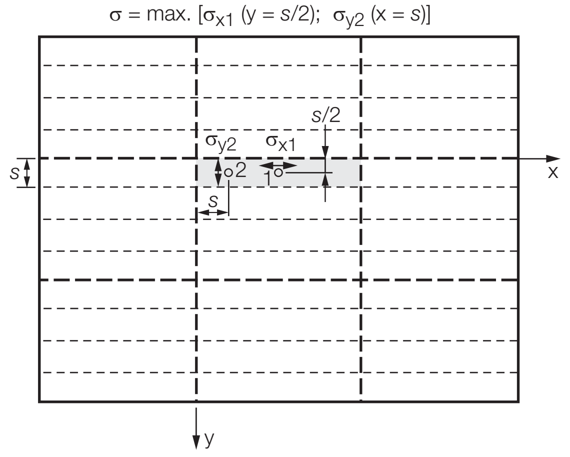


**Fig. 11.2.1**
**Determination of normal stress of the hatch cover plating**

## 2.6 Local plate thickness of hatch covers for wheel loading and helicopter landing

*2.6.1* The local gross plate thickness of hatch covers for wheel loading is to comply with Ch 9,3.

*2.6.2* The local gross plate thickness of hatch covers for helicopter landing is to comply with Ch 9,5.

## 2.7 Lower plating of double skin hatch covers and box girders

*2.7.1* The thickness to fulfil the strength requirements is to be obtained from the calculation according to 2.10 under consideration of permissible stresses according to 2.4.1. The net thickness must not be less than the larger of the following values when the lower plating is taken into account as a strength member of the hatch cover:

$t$ = $0{,}0065s$, in mm

$t_{min}$ = 5 mm

$s$ = stiffener spacing, in mm.

### 2.8 Net scantling of secondary stiffeners

*2.8.1* The net section modulus $Z$ and net shear area $A_s$ of uniformly loaded hatch cover stiffeners constrained at both ends is not to be less than:

$$Z = \frac{0,104}{\sigma_o} s\, l^2\, p, \text{ in cm}^3$$

$$A_s = \frac{0,01}{\sigma_o} s\, l\, p \text{ , in cm}^2$$

where

$l$ = secondary stiffener span, in metres, to be taken as the spacing, in metres, of primary supporting members or the distance between a primary supporting member and the edge support, as applicable

$s$ = secondary stiffener spacing, in mm

$p$ = pressure $p_H$ and $p_L$, in kN/m$^2$, as defined in 2.3.

*2.8.2* The net section modulus of the secondary stiffeners is to be determined, based on an attached plate width assumed equal to the stiffener spacing.

*2.8.3* For flat bar secondary stiffeners and buckling stiffeners, the ratio $h/t_w$ is to be not greater than $15k^{0,5}$

where

$h$ = height of the stiffener

$t_w$ = net thickness of the stiffener

$k$ = $235/\sigma_o$.

*2.8.4* Stiffeners parallel to primary supporting members and arranged within the effective breadth according to 2.10 must be continuous when crossing primary supporting members and may be considered when calculating the cross-sectional properties of primary supporting members. It is to be verified that the combined stress of those stiffeners, induced by the bending of primary supporting members and lateral pressures, does not exceed the permissible stresses according to 2.4.1.

*2.8.5* For hatch cover stiffeners under compression, sufficient safety against lateral and torsional buckling according to 2.15 and 2.16 is to be verified.

*2.8.6* For hatch covers subject to wheel loading, stiffener gross scantlings are to comply with Ch 9,3.

*2.8.7* For hatch covers subject to helicopter landing, stiffener gross scantlings are to comply with Ch 9,5.

### 2.9 Net scantling of primary supporting members

*2.9.1* Scantlings of primary supporting members are obtained from calculations according to 2.10, under consideration of permissible stresses according to 2.4.1.

*2.9.2* For all components of primary supporting members, sufficient safety against buckling must be verified according to 2.11 to 2.16. For biaxial compressed flange plates, this is to be verified within the effective widths according to 2.14.1.

*2.9.3* The net thickness, $t$, in mm, of webs of primary supporting members is not to be less than:

(a) $0,0065s$, in mm

(b) 5 mm

where

$s$ = stiffener spacing, in mm.

*2.9.4* Scantlings of edge girders (skirt plates) are obtained from the calculations according to 2.10, under consideration of permissible stresses according to 2.4.1.

*2.9.5* The net thickness, $t$, in mm, of the outer edge girders exposed to wash of sea is not to be less than the largest of the following values:

(a) $0,0158s \sqrt{\dfrac{p_A}{0,95\sigma_o}}$

(b) $0,0085s$ mm

(c) 5 mm

where

$p_A$ = horizontal pressure, as defined in 2.3.3

$s$ = stiffener spacing, in mm.

*2.9.6* The stiffness of edge girders is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, in cm$^4$, of edge girders is not to be less than:

$I$ = $6q\, s_{SD}{}^4$

$q$ = packing line pressure, in N/mm, minimum 5 N/mm

$s_{SD}$ = spacing, in metres, of securing devices.

### 2.10 Strength calculations

*2.10.1* Strength calculation for hatch covers may be carried out by using either beam theory, grillage analysis or FEM.

*2.10.2* The effective cross-sectional properties for calculation by beam theory or grillage analysis are to be determined considering the effective breadth. Cross-sectional areas of secondary stiffeners parallel to the primary supporting member under consideration within the effective breadth can be included, *see* Fig. 11.2.3. The effective breadth of plating, $e_m$, of primary supporting members is to be determined according to Table 11.2.3, considering the type of loading. Special calculations may be required for determining the effective breadth of one-sided or non-symmetrical flanges. The effective cross-sectional area of plates is not to be less than the cross-sectional area of the face-plate. For flange plates under compression with secondary stiffeners perpendicular to the web of the primary supporting member, the effective width is to be determined according to 2.14.1.

**Table 11.2.3 Effective breadth $e_m$ of plating of primary supporting members**

| $l/e$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | ≥8 |
|---|---|---|---|---|---|---|---|---|---|
| $e_{m1}/e$ | 0 | 0,36 | 0,64 | 0,82 | 0,91 | 0,96 | 0,98 | 1,00 | 1,00 |
| $e_{m2}/e$ | 0 | 0,20 | 0,37 | 0,52 | 0,65 | 0,75 | 0,84 | 0,89 | 0,90 |

Symbols

$e_{m1}$ is to be applied where primary supporting members are loaded by uniformly distributed loads or else by no fewer than six equally spaced single loads

$e_{m2}$ is to be applied where primary supporting members are loaded by 3 or fewer single loads. Intermediate values may be obtained by direct interpolation

$l$ length of zero-points of bending moment curve:
$l = l_0$ for simply supported primary supporting members
$l = 0{,}6l_0$ for primary supporting members with both ends constrained

where

$l_0$ is the unsupported length of the primary supporting member

$e$ width of plating supported, measured from centre to centre of the adjacent unsupported fields

## 2.11 Buckling strength of hatch cover structures

*2.11.1* For hatch cover structures, sufficient buckling strength is to be demonstrated.

$a$ = length of the longer side of a single plate field, in mm
$b$ = breadth of the shorter side of a single plate field, in mm
$\alpha$ = aspect ratio of single plate field
= $a/b$
$n$ = number of single plate field breadths within the partial or total plate field
$t$ = net plate thickness in mm
$\sigma_x$ = membrane stress, in N/mm$^2$, in x-direction
$\sigma_y$ = membrane stress, in N/mm$^2$, in y-direction
$\tau$ = shear stress, in N/mm$^2$, in the x-y plane
$E$ = modulus of elasticity, in N/mm$^2$, of the material
= $2{,}06 \times 10^5$ N/mm$^2$ for steel
$\sigma_F$ = minimum yield stress, in N/mm$^2$, of the material.

Compressive and shear stresses are to be taken positive, tension stresses are to be taken negative.

If stresses in the x- and y-direction already contain the Poisson effect (calculated using FEM), the following modified stress values may be used. Both stresses $\sigma_x^*$ and $\sigma_y^*$ are to be compressive stresses, in order to apply the stress reduction according to the following formulae.

$$\sigma_x = \frac{(\sigma_x^* - 0{,}3\sigma_y^*)}{0{,}91}$$

$$\sigma_y = \frac{(\sigma_y^* - 0{,}3\sigma_x^*)}{0{,}91}$$

$\sigma_x^*, \sigma_y^*$ = stresses containing the Poisson effect where compressive stress fulfils the condition
$\sigma_y^* < 0{,}3\sigma_x^*$, then $\sigma_y = 0$ and $\sigma_x = \sigma_x^*$
where compressive stress fulfils the condition
$\sigma_x^* < 0{,}3\sigma_y^*$, then $\sigma_x = 0$ and $\sigma_y = \sigma_y^*$
$F_1$ = correction factor for boundary condition at the longitudinal stiffeners according to Table 11.2.4
$\sigma_e$ = reference stress, in N/mm$^2$, taken equal to

$$= 0{,}9E\left(\frac{t}{b}\right)^2$$

$\psi$ = edge stress ratio taken equal to

$$= \frac{\sigma_2}{\sigma_1}$$

where

$\sigma_1$ = maximum compressive stress
$\sigma_2$ = minimum compressive stress or tension stress
$S$ = safety factor (based on net scantling approach), taken equal to
= 1,25 for hatch covers when subjected to the vertical weather design load according to 2.3.2
= 1,10 for hatch covers when subjected to loads according to 2.3.3 to 2.3.6 and Pt 4, Ch 8,11,2
$\lambda$ = reference degree of slenderness, taken equal to:

$$= \sqrt{\frac{\sigma_o}{K\sigma_e}}$$

$K$ = buckling factor according to Table 11.2.6.

**Table 11.2.4 Correction factor $F_1$**

| | | |
|---|---|---|
| Stiffeners sniped at both ends | 1,00 | |
| Guidance values, *see* Note 1, where both ends are effectively connected to adjacent structures | 1,05<br>1,10<br>1,21<br>1,30 | for flat bars<br>for bulb sections<br>for angle and tee-sections<br>for u-type sections, *see* Note 2, and girders of high rigidity |
| An average value of $F$, *see* Note 1, is to be used for plate panels having different edge stiffeners | | |

NOTES
1. Exact values may be determined by direct calculations.
2. A higher value, but not greater than 2,0, may be taken if it is verified by a buckling strength check of the partial plate field using non-linear FEA. The calculations are to be submitted to LR for approval.

**Table 11.2.5 Coefficients $e_1$, $e_2$, $e_3$ and factor $B$**

| Exponents $e_1$ to $e_3$ and factor B | Plate panel |
|---|---|
| $e_1$ | $1 + \kappa_x^4$ |
| $e_2$ | $1 + \kappa_y^4$ |
| $e_3$ | $1 + \kappa_x \kappa_y \kappa_\tau^2$ |
| $B$<br>$\sigma_x$ and $\sigma_y$ positive<br>(compression stress) | $(\kappa_x \kappa_y)^5$ |
| $B$<br>$\sigma_x$ or $\sigma_y$ negative<br>(tension stress) | 1 |

*2.11.2* Proof is to be provided that the following condition is complied with for the single plate field *a b*:

$$\left(\frac{|\sigma_x|\,S}{\kappa_x\,\sigma_o}\right)^{e1}+\left(\frac{|\sigma_y|\,S}{\kappa_y\,\sigma_o}\right)^{e2}-B\left(\frac{\sigma_x\,\sigma_y\,S^2}{\sigma_o^2}\right)+\left(\frac{|\tau|\,S\sqrt{3}}{\kappa_\tau\,\sigma_o}\right)^{e3}\le 1{,}0$$

The first two terms and the last term of the above condition shall not exceed 1,0.
The reduction factors $\kappa_x$, $\kappa_y$ and $\kappa_\tau$ are given in Table 11.2.6.
Where $\sigma_x \le 0$ (tension stress), $\kappa_x = 1{,}0$.
Where $\sigma_y \le 0$ (tension stress), $\kappa_y = 1{,}0$.
The exponents $e_1$, $e_2$ and $e_3$ as well as the factor $B$ are to be taken as given by Table 11.2.5.

## 2.12 Webs and flanges of primary supporting members

*2.12.1* For non-stiffened webs and flanges of primary supporting members, sufficient buckling strength, as for the hatch cover top and lower plating, is to be demonstrated according to 2.11.2.

## 2.13 Longitudinal and transverse secondary stiffeners

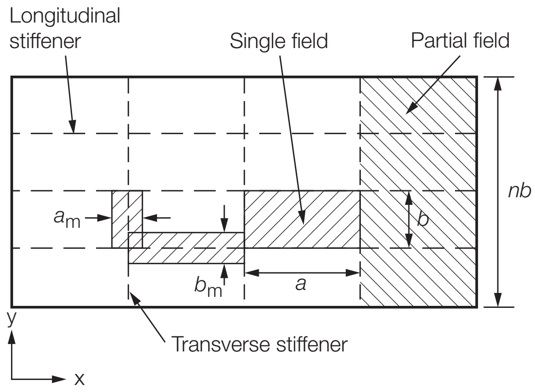
*2.13.1* It is to be demonstrated that the continuous longitudinal and transverse stiffeners of partial and total plate fields comply with the conditions set out in 2.15 and 2.16.

## 2.14 Effective width of top and lower hatch cover plating

*2.14.1* For demonstration of buckling strength according to 2.15 and 2.16, the effective width of plating may be determined by the following formulae:

$b_m = \kappa_x\, b$ for longitudinal stiffeners
$a_m = \kappa_y\, a$ for transverse stiffeners

*see also* Fig. 11.2.2.
The effective width of plating is not to be taken greater than the value obtained from 2.10.2.
The effective width $e'_m$ of stiffened flange plates of primary supporting members may be determined as follows:



Longitudinal : stiffener in the direction of the length *a*
Transverse : stiffener in the direction of the length *b*

**Fig. 11.2.2**
**General arrangement of panel**

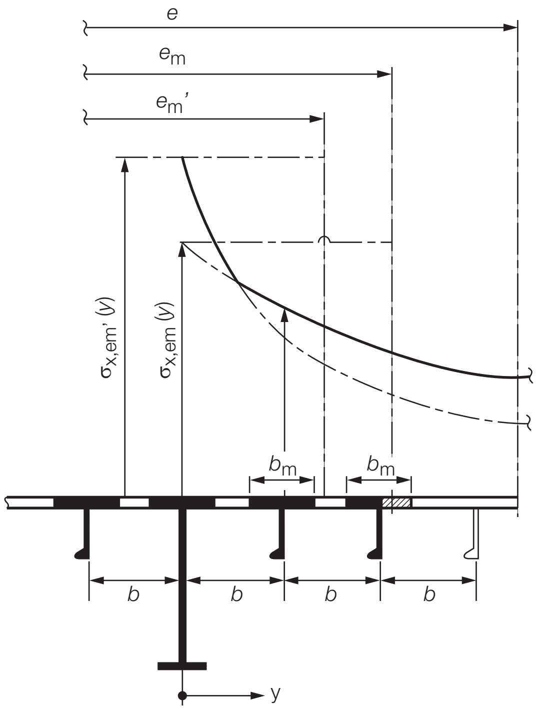


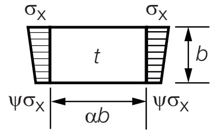
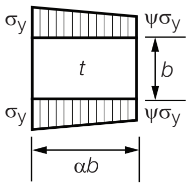
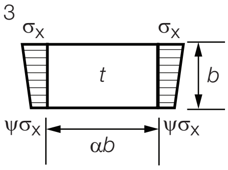
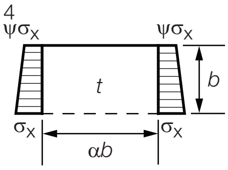
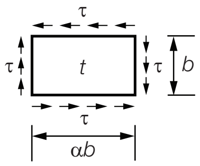
**Fig. 11.2.3**
**Stiffening parallel to web of primary supporting member**

(a) Stiffening parallel to web of primary supporting member:

$b < e_m$
$e'_m = n\, b_m$
$n$ = integer number of stiffener spacings $b$ inside the effective breadth $e_m$ according to 2.10.2

$$= \text{int}\left(\frac{e_m}{b}\right)$$

**Table 11.2.6 Buckling and reduction factors for plane elementary plate panels**

| Buckling load case | Edge stress ratio $\psi$ | Asp. ratio $\alpha = \frac{a}{b}$ | Buckling factor $K$ | Reduction factor $\kappa$ |
|---|---|---|---|---|
| 1   $\sigma_x$<br>$\sigma_x$<br>$t$<br>$b$<br>$\psi\sigma_x$<br>$\alpha b$<br>$\psi\sigma_x$ | $1 \ge \psi \ge 0$ | $\alpha \ge 1$ | $K = \frac{8,4}{\psi + 1,1}$ | $K_x = 1 \quad \text{for } \lambda \le \lambda_c$<br>$K_x = c\left(\frac{1}{\lambda} - \frac{0,22}{\lambda^2}\right) \quad \text{for } \lambda > \lambda_c$<br>$c = (1,25 - 0,12\psi) \le 1,25$<br>$\lambda_c = \frac{c}{2}\left(1 + \sqrt{1 - \frac{0,88}{c}}\right)$ |
| | $0 > \psi > -1$ | | $K = 7,63 - \psi\,(6,26 - 10\psi)$ | |
| | $\psi \le -1$ | | $K = 5,975\,(1 - \psi)^2$ | |
| 2   $\sigma_y$<br>$\psi\sigma_y$<br>$t$<br>$b$<br>$\sigma_y$<br>$\psi\sigma_y$<br>$\alpha b$ | $1 \ge \psi \ge 0$ | $\alpha \ge 1$ | $K = F_1\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2,1}{(\psi + 1,1)}$ | $K_y = c\left(\frac{1}{\lambda} - \frac{R + F^2(H - R)}{\lambda^2}\right)$<br>$c = (1,25 - 0,12\psi) \le 1,25$<br>$R = \lambda\left(1 - \frac{\lambda}{c}\right) \quad \text{for } \lambda < \lambda_c$<br>$R = 0,22 \quad \text{for } \lambda \ge \lambda_c$<br>$\lambda_c = \frac{c}{2}\left(1 + \sqrt{1 - \frac{0,88}{c}}\right)$<br>$F = \left(1 - \frac{\frac{K}{0,91} - 1}{\lambda_p^2}\right) \quad c_1 \ge 0$<br>$\lambda_p^2 = \lambda^2 - 0,5 \quad \text{for } 1 \le \lambda_p^2 \le 3$<br>$c_1 = \left(1 - \frac{F_1}{\alpha}\right) \ge 0$<br>$H = \lambda - \frac{2\lambda}{c\,(T + \sqrt{T^2 - 4})} \ge R$<br>$T = \lambda + \frac{14}{15\lambda} + \frac{1}{3}$ |
| | $0 > \psi > -1$ | $1 \le \alpha \le 1,5$ | $K = F_1\left[\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2,1\,(1 + \psi)}{1,1} - \frac{\psi}{\alpha^2}\,(13,9 - 10\psi)\right]$ | |
| | | $\alpha > 1,5$ | $K = F_1\left[\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2,1\,(1 + \psi)}{1,1} - \frac{\psi}{\alpha^2}\,\left(5,87 + 1,87\alpha^2 + \frac{8,6}{\alpha^2} - 10\psi\right)\right]$ | |
| | $\psi \le -1$ | $1 \le \alpha \le \frac{3\,(1 - \psi)}{4}$ | $K = 5,975F_1\left(\frac{1 - \psi}{\alpha}\right)^2$ | |
| | | $\alpha > \frac{3\,(1 - \psi)}{4}$ | $K = F_1\left[3,9675\left(\frac{1 - \psi}{\alpha}\right)^2 + 0,5375\left(\frac{1 - \psi}{\alpha}\right)^4 + 1,87\right]$ | |
| 3   $\sigma_x$<br>$\sigma_x$<br>$t$<br>$b$<br>$\psi\sigma_x$<br>$\alpha b$<br>$\psi\sigma_x$ | $1 \ge \psi \ge 0$ | $\alpha > 0$ | $K = \frac{4\left(0,425 + \frac{1}{\alpha^2}\right)}{3\psi + 1}$ | $\kappa_x = 1 \quad \text{for } \lambda \le 0,7$<br>$\kappa_x = \frac{1}{\lambda^2 + 0,51} \quad \text{for } \lambda > 0,7$ |
| | $0 > \psi \ge -1$ | | $K = 4\left(0,425 + \frac{1}{\alpha^2}\right)(1 + \psi) - 5\psi\,(1 - 3,42\psi)$ | |
| 4   $\psi\sigma_x$<br>$\psi\sigma_x$<br>$t$<br>$b$<br>$\sigma_x$<br>$\alpha b$<br>$\sigma_x$ | $1 \ge \psi \ge -1$ | $\alpha > 0$ | $K = \left(0,425 + \frac{1}{\alpha^2}\right)\frac{3 - \psi}{2}$ | |
| 5   $\tau$<br>$\tau$<br>$t$<br>$\tau$<br>$b$<br>$\tau$<br>$\alpha b$ | — | | $K = K_\tau\sqrt{3}$ | $\kappa_\tau = 1 \quad \text{for } \lambda \le 0,84$<br>$\kappa_\tau = \frac{0,84}{\lambda} \quad \text{for } \lambda > 0,84$ |
| | | $\alpha \ge 1$ | $K_\tau = \left(5,34 + \frac{4}{\alpha^2}\right)$ | |
| | | $0 < \alpha < 1$ | $K_\tau = \left(4 + \frac{5,34}{\alpha^2}\right)$ | |

Explanations for boundary conditions
- - - - - - - - plate edge free
———————— plate edge simply supported

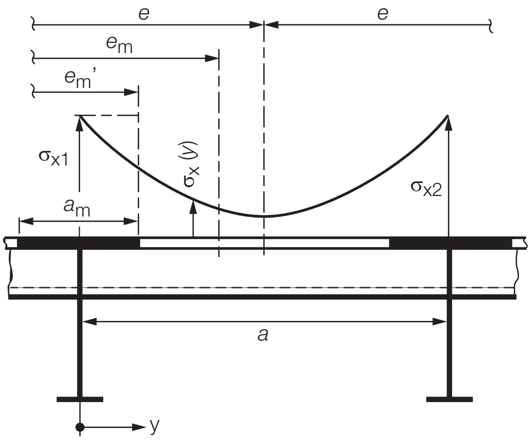


**Fig. 11.2.4**
**Stiffening perpendicular to web of primary supporting member**

(b) Stiffening perpendicular to web of primary supporting member:

$a \ \geq \ e_m$

$e'_m \ = n\, a_m < e_m$

$n \ = 2{,}7 \ \dfrac{e_m}{a} \ \leq l$

$e$ = width of plating supported according to 2.10.2

For $b \geq e_m$ or $a < e_m$, respectively, $b$ and $a$ are to be exchanged

$a_m$ and $b_m$ for flange plates are in general to be determined for $\psi = 1$

Scantlings of plates and stiffeners are in general to be determined according to the maximum stresses $\sigma_x\,(y)$ at webs of primary supporting member and stiffeners, respectively. For stiffeners with spacing $b$ under compression arranged parallel to primary supporting members, no value less than $0{,}25\sigma_o$ shall be inserted for $\sigma_x\,(y{=}b)$.

The stress distribution between two primary supporting members can be obtained by the following formula:

$$\sigma_x(y) \ = \sigma_{x1}\left\{1 - \frac{y}{e}\left[3 + c_1 - 4c_2 - 2\,\frac{y}{e}\,(1 + c_1 - 2c_2)\right]\right\}$$

where

$c_1 \ = \dfrac{\sigma_{x2}}{\sigma_{x1}} \quad 0 \leq c_1 \leq 1$

$c_2 \ = \dfrac{1{,}5}{e}\ (e_{m1}" + e_{m2}") - 0{,}5$

$e_{m1}"$ = proportionate effective breadth $e_{m1}$ or proportionate effective width $e_{m1}$' of primary supporting member 1 within the distance $e$, as appropriate

$e_{m2}"$ = proportionate effective breadth $e_{m2}$ or proportionate effective width $e_{m2}$' of primary supporting member 2 within the distance $e$, as appropriate

$\sigma_{x1}$, $\sigma_{x2}$ = normal stresses in flange plates of adjacent primary supporting member 1 and 2 with spacing $e$, based on cross-sectional properties considering the effective breadth or effective width, as appropriate

$y$ = distance of considered location from primary supporting member 1

Shear stress distribution in the flange plates may be assumed linearly.

### 2.15 Lateral buckling of secondary stiffeners

*2.15.1* The secondary stiffeners are to comply with the following criteria:

$$\frac{\sigma_a + \sigma_b}{\sigma_o}\ S \leq 1$$

where

$\sigma_a$ = uniformly distributed compressive stress, in N/mm$^2$, in the direction of the stiffener axis

$\sigma_a$ = $\sigma_x$ for longitudinal stiffeners

$\sigma_a$ = $\sigma_y$ for transverse stiffeners

$\sigma_b$ = bending stress, in N/mm$^2$, in the stiffener

$\quad = \dfrac{M_0 + M_1}{Z_{st} \times 10^3}$

$M_0$ = bending moment, in Nmm, due to the deformation $w$ of stiffener, taken equal to:

$M_0 \ = F_{Ki}\ \dfrac{p_z\, w}{c_f - p_z} \quad$ with $(c_f - p_z) > 0$

$M_1$ = bending moment, in Nmm, due to the lateral load $p$ equal to:

$M_1 \ = \dfrac{p\, b\, a^2}{24 \times 10^3}$ for longitudinal stiffeners

$M_1 \ = \dfrac{p\, a\, (n\, b)^2}{8c_s \times 10^3}$ for transverse stiffeners

$n$ is to be taken equal to 1 for ordinary transverse stiffeners

$p$ = lateral load, in kN/m$^2$

$F_{Ki}$ = ideal buckling force, in N, of the stiffener

$F_{Kix} \ = \dfrac{\pi^2}{a^2}\ E\, I_x \times 10^4$ for longitudinal stiffeners

$F_{Kiy} \ = \dfrac{\pi^2}{(n\, b)^2}\ E\, I_y \times 10^4$ for transverse stiffeners

$I_x$, $I_y$ = net moments of inertia, in cm$^4$, of the longitudinal or transverse stiffener, including effective width of attached plating according to 2.14.1. $I_x$ and $I_y$ are to comply with the following criteria:

$I_x \ \geq \ \dfrac{b\, t^3}{12 \times 10^4}$

$I_y \ \geq \ \dfrac{a\, t^3}{12 \times 10^4}$

$p_z$ = nominal lateral load, in N/mm$^2$, of the stiffener due to $\sigma_x$, $\sigma_y$ and $\tau$

$$p_{zx} \ = \frac{t}{b}\left(\sigma_{xl}\left(\frac{\pi\, b}{a}\right)^2 + 2c_y\,\sigma_y + \sqrt{2}\,\tau_1\right)$$

for longitudinal stiffeners

$$p_{zy} \ = \frac{t}{a}\left(2c_x\,\sigma_{xl} + \sigma_y\left(\frac{\pi\, a}{n\, b}\right)^2\left(1 + \frac{A_y}{a\, t}\right) + \sqrt{2}\,\tau_1\right)$$

for transverse stiffeners

$$\sigma_{xl} \ = \sigma_x\left(1 + \frac{A_x}{b\, t}\right)$$

$c_x$, $c_y$ = factor taking into account the stresses perpendicular to the stiffener's axis and distributed variably along the stiffener's length
= $0,5\,(1 + \psi)$ for $0 \leq \psi \leq 1$
= $\dfrac{0,5}{1 - \psi}$ for $\psi < 0$
$A_x$, $A_y$ = net sectional area, in mm$^2$, of the longitudinal or transverse stiffener, respectively, without attached plating

$$\tau_1 = \left[\tau - t\sqrt{\sigma_o E\left(\frac{m_1}{a^2} + \frac{m_2}{b^2}\right)}\right] \geq 0$$

for longitudinal stiffeners:

$\dfrac{a}{b} \geq 2,0$ : $m_1 = 1,47$ $m_2 = 0,49$

$\dfrac{a}{b} < 2,0$ : $m_1 = 1,96$ $m_2 = 0,37$

for transverse stiffeners:

$\dfrac{a}{n\,b} \geq 0,5$ : $m_1 = 0,37$ $m_2 = \dfrac{1,96}{n^2}$

$\dfrac{a}{n\,b} < 0,5$ : $m_1 = 0,49$ $m_2 = \dfrac{1,47}{n^2}$

$w$ = $w_0 + w_1$
$w_0$ = assumed imperfection, in mm
$w_{0x}$ = $\leq \min\left(\dfrac{a}{250}, \dfrac{b}{250}, 10\right)$ for longitudinal stiffeners
$w_{0y}$ = $\leq \min\left(\dfrac{a}{250}, \dfrac{n\,b}{250}, 10\right)$ for transverse stiffeners

NOTE
For stiffeners sniped at both ends, $w_o$ must not be taken less than the distance from the midpoint of plating to the neutral axis of the profile, including effective width of plating

$w_1$ = deformation of stiffener, in mm, at midpoint of stiffener span due to lateral load $p$

In the case of uniformly distributed load, the following values for $w_1$ may be used:

$w_1 = \dfrac{p\,b\,a^4}{384 \times 10^7\,E\,I_x}$ for longitudinal stiffeners

$w_1 = \dfrac{5a\,p\,(n\,b)^4}{384 \times 10^7\,E\,I_y\,c_s{}^2}$ for transverse stiffeners

$c_f$ = elastic support provided by the stiffener, in N/mm$^2$

(i) For longitudinal stiffeners:

$$c_{fx} = F_{Kix}\,\frac{\pi^2}{a^2}\,(1 + c_{px})$$

$$c_{px} = \frac{1}{1 + \dfrac{0,91\left(\dfrac{12 \text{ x } 10^4\,I_x}{t^3\,b} - 1\right)}{c_{xa}}}$$

$c_{xa} = \left(\dfrac{a}{2b} + \dfrac{2b}{a}\right)^2$ for $a \geq 2b$

$c_{xa} = \left(1 + \left(\dfrac{a}{2b}\right)^2\right)^2$ for $a < 2b$

(ii) For transverse stiffeners:

$$c_{fy} = c_S\,F_{Kiy}\,\frac{\pi^2}{(n\,b)^2}\,(1 + c_{py})$$

$$c_{py} = \frac{1}{1 + \dfrac{0,91\left(\dfrac{12 \text{ x } 10^4\,I_y}{t^3\,a} - 1\right)}{c_{ya}}}$$

$c_{ya} = \left(\dfrac{n\,b}{2a} + \dfrac{2a}{n\,b}\right)^2$ for $n\,b \geq 2a$

$c_{ya} = \left(1 + \left(\dfrac{n\,b}{2a}\right)^2\right)^2$ for $n\,b < 2a$

$c_s$ = factor accounting for the boundary conditions of the transverse stiffener
= 1,0 for simply supported stiffeners
= 2,0 for partially constrained stiffeners
$Z_{st}$ = net section modulus of stiffener (longitudinal or transverse), in cm$^3$, including effective width of plating according to 2.14.1.

If no lateral load $p$ is acting, the bending stress $\sigma_b$ is to be calculated at the midpoint of the stiffener span for that fibre which results in the largest stress value. If a lateral load $p$ is acting, the stress calculation is to be carried out for both fibres of the stiffener's cross-sectional area (if necessary for the biaxial stress field at the plating side).

### 2.16 Torsional buckling of secondary stiffeners

*2.16.1* The longitudinal secondary stiffeners are to comply with the following criteria:

$$\frac{\sigma_x\,S}{\kappa_T\,\sigma_o} \leq 1,0$$

where

$\kappa_T$ = coefficient taken equal to:
$\kappa_T$ = 1,0 for $\lambda_T \leq 0,2$
$\kappa_T = \dfrac{1}{\phi + \sqrt{\phi^2 - \lambda_T{}^2}}$ for $\lambda_T > 0,2$
$\phi$ = $0,5\,(1 + 0,21\,(\lambda_T - 0,2) + \lambda_T{}^2)$
$\lambda_T$ = reference degree of slenderness taken equal to:

$$\lambda_T = \sqrt{\frac{\sigma_F}{\sigma_{KiT}}}$$

$$\sigma_{KiT} = \frac{E}{I_p}\left(\frac{\pi^2\,I_\omega 10^2}{a^2}\,\varepsilon + 0,385 I_T\right), \text{ in N/mm}^2$$

For $I_P$, $I_T$, $I_\omega$, *see* Fig. 11.2.5 and Table 11.2.7

$I_P$ = net polar moment of inertia of the stiffener, in cm$^4$, related to the point $C$
$I_T$ = net St.Venant's moment of inertia of the stiffener, in cm$^4$
$I_\omega$ = net sectorial moment of inertia of the stiffener, in cm$^6$, related to the point $C$
$\varepsilon$ = degree of fixation taken equal to:

$$\varepsilon = 1 + 10^{-3}\sqrt{\frac{a^4}{\dfrac{3}{4}\,\pi^4\,I_\omega\left(\dfrac{b}{t^3} + \dfrac{4h_w}{3t_w{}^3}\right)}}$$

$h_w$ = web height, in mm
$t_w$ = net web thickness, in mm
$b_f$ = flange breadth, in mm

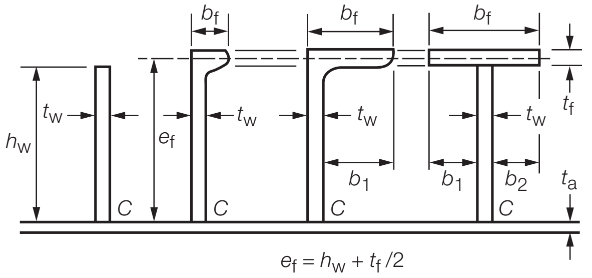


**Fig. 11.2.5 Dimensions of stiffener**

$t_f$ = net flange thickness, in mm
$A_w$ = net web area equal to: $A_w = h_w\, t_w$
$A_f$ = net flange area equal to: $A_f = b_f\, t_f$
$e_f = h_w + \dfrac{t_f}{2}$, in mm
$b$ = stiffener spacing, in mm
$t$ = local net plate thickness of the attached plate, in mm.

2.16.2 For transverse secondary stiffeners loaded by compressive stresses and which are not supported by longitudinal stiffeners, sufficient torsional buckling strength is to be demonstrated analogously in accordance with this sub-Section.

**Table 11.2.7 Moments of inertia**

| Section | $I_P$ | $I_T$ | $I_\omega$ |
|---|---|---|---|
| Flat bar | $\dfrac{h_w^3\, t_w}{3 \times 10^4}$ | $\dfrac{h_w\, t_w^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_w}{h_w}\right)$ | $\dfrac{h_w^3\, t_w^3}{36 \times 10^6}$ |
| Sections with bulb or flange | $\left(\dfrac{A_w\, h_w^2}{3} + A_f\, e_f^2\right) 10^{-4}$ | $\dfrac{h_w\, t_w^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_w}{h_w}\right) +$<br>$\dfrac{b_f\, t_f^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_f}{b_f}\right)$ | for bulb and angle sections:<br>$\dfrac{A_f\, e_f^2\, b_f^2}{12 \times 10^6}\left(\dfrac{A_f + 2{,}6A_W}{A_f + A_W}\right)$<br>for tee sections:<br>$\dfrac{b_f^3\, t_f\, e_f^2}{12 \times 10^6}$ |

**Table 11.2.8 Pontoon cover minimum design pressures**

For ships of 100 m in length and above:

(a) Position 1 hatch covers located in the forward quarter of the ship's length shall be designed for wave pressures at the forward perpendicular, calculated from the following equation:
Minimum design pressure, $p = 49{,}05 + 9{,}81\,(L_H - 100)\,a$ in kN/m$^2$
where
$L_H$ is $L$ for ships of not more than 340 m but not less than 100 m in length and equal to 340 m for ships of more than 340 m in length:
$a$ = 0,0074 for Type B freeboard ships
= 0,0363 ships assigned reduced freeboard
The pressure, $p$, is to be reduced linearly to 34,3 kN/m$^2$ at the end of the forward quarter's length, as shown in Table 11.2.9
The design pressure used for each hatch cover panel shall be that determined at its midpoint location:
(b) All other position 1 hatch covers shall be designed to 34,3 kN/m$^2$
(c) Position 2 hatch covers shall be designed to 25,5 kN/m$^2$
(d) Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, it may be designed to 34,3 kN/m$^2$

For ships 24 m in length:

(a) Position 1 hatch covers located in the forward quarter of the ship's length shall be designed for wave pressures of 23,8 kN/m$^2$ at the forward perpendicular and reduced linearly to 19,6 kN/m$^2$ at the end of the forward quarter's length, as shown in Table 11.2.9
The design pressure used for each hatch cover panel shall be that determined at its midpoint location
(b) All other position 1 hatch covers shall be designed to 19,6 kN/m$^2$
(c) Position 2 hatch covers shall be designed to 14,7 kN/m$^2$
(d) Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, it may be designed to 19,6 $t$/m$^2$

For ships between 24 m and 100 m in length, and for positions between FP and 0,25$L$, wave pressures shall be obtained by linear interpolation of the values shown in Table 11.2.9

### 2.17 Pontoon covers

*2.17.1* The structural assessment of pontoon covers, as defined in 1.1.5(b), is to be carried out by direct calculations, which are to be submitted for approval, using the minimum design pressures acting on the hatch covers defined in Table 11.2.8. The permissible stress, deflection and buckling criteria are given in Table 11.2.10.

*2.17.2* The gross thickness of the plating of steel pontoon covers is to be not less than the greater of:

(a) $t = 0{,}01s$ mm
(b) $t = 6{,}0$ mm as required by Table 11.2.8
where
$s$ = stiffener spacing in mm
$t$ = thickness as required by 2.17.1.

*2.17.3* The gross scantlings of steel pontoon cover primary and secondary webs or stiffeners are to be not less than would be required to satisfy the requirements of Table 11.2.11. Alternatively, scantlings may be determined by direct calculations, which are to be submitted for approval. In no case are the stresses and deflections given in Table 11.2.10 to be exceeded.

*Existing* Fig. 11.1.1 *has been renumbered* Fig. 11.2.6.

*Existing* Fig. 11.1.2 *has been renumbered* Fig. 11.2.7.

**Table 11.2.9 Summary of pontoon cover minimum design pressures**

| Deck location | Longitudinal position | | |
|---|---|---|---|
| | FP | 0,25*L* | Aft of 0,25*L* |
| *L*>100 m | | | |
| Freeboard deck | Equation given in Table 11.2.8(a) | 34,3 kN/m$^2$ | 34,3 kN/m$^2$ |
| Superstructure deck | 34,3 kN/m$^2$ | | 25,5 kN/m$^2$ |
| | *L* = 100 m | | |
| Freeboard deck | 49,05 kN/m$^2$ | 34,3 kN/m$^2$ | 34,3 kN/m$^2$ |
| Superstructure deck | 34,3 kN/m$^2$ | | 25,5 kN/m$^2$ |
| | *L* = 24 m | | |
| Freeboard deck | 23,84 kN/m$^2$ | 19,6 kN/m$^2$ | 19,6 kN/m$^2$ |
| Superstructure deck | 19,6 kN/m$^2$ | | 14,7 kN/m$^2$ |

**Table 11.2.10 Steel pontoon cover permissible stress, deflection and buckling criteria**

| Location | Permissible bending stress, N/mm$^2$ | Permissible shear stress, N/mm$^2$ | Permissible deflection, metres |
|---|---|---|---|
| Weather deck – Positions 1 and 2 | $0{,}68\sigma_o$ | $0{,}39\sigma_o$ | $0{,}0044l_0$ |

Buckling requirements

Symbols

$b$ = length of panel (longer panel dimension), in mm, in transverse direction, *see* Fig. 11.2.6
$s$ = spacing of webs and stiffeners (shorter panel dimension), in mm
$t$ = thickness of plating, in mm
$\sigma_{ac}$ = corrected critical buckling stress, in N/mm$^2$
$\sigma_b$ = the compressive bending stress, in N/mm$^2$, in the steel cover plating, calculated by taking the cover as a loaded beam simply supported at its ends
$\sigma_c$ = critical buckling stress of panel, in N/mm$^2$
$\sigma_o$ = yield stress of cover plating material, in N/mm$^2$

$$\sigma_c = 18{,}6R_c\left(\frac{t}{b}\right)^2 \times 10^4 \quad \text{N/mm}^2$$

$$\sigma_{ac} = \sigma_o\left(1 - \frac{\sigma_o}{4\sigma_c}\right) \quad \text{N/mm}^2$$

(a) Where primary bending stress acts on longer panel edge $b$, *see* Fig. 11.2.6:

$$\frac{\sigma_c}{\sigma_b}\left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \geq 1{,}3 \qquad \text{where } R_c = \left(\frac{s}{b} + \frac{b}{s}\right)^2$$

Where primary bending stress acts on shorter panel edge $s$:

$$\frac{\sigma_c}{\sigma_b}\left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \geq 1{,}2 \qquad \text{where } R_c = 4\left(\frac{b^2}{s^2}\right)$$

If $\sigma_c > 0{,}5\,\sigma_o$, then corrected value $\sigma_{ac}$ is used

It is recommended that $\dfrac{b}{s} < 5{,}0$

(b) Where covers are stiffened in two directions by a grillage formation, buckling checks are to be carried out as per (a) above for bending stresses acting on both the longer and shorter edges of the panel

For the derivation of the section modulus for primary members, an effective width of plating to achieve a balanced section is to be adopted

However, a greater width of plating in accordance with Ch 3,3.2 may be adopted where this is suitably stiffened in the directions being considered from the buckling aspect

**Table 11.2.11 Steel pontoon cover webs and stiffeners**

| Symbols | Primary and secondary stiffening requirements |
|---|---|
| $A_s$ = shear area, in cm$^2$<br>$K$ = higher tensile steel factor, *see* Ch 2,1.2<br>$K_1$ = 1281<br>$C_1$ = 696<br>$I_0$ = moment of inertia at mid-span, in cm$^4$<br>$I_1$ = moment of inertia at supports, in cm$^4$<br>where<br>$I_1$ > 0,05 $I_0$<br>$l_0$ = unsupported span, in metres, measured as shown in Fig. 11.2.7<br>$l_1$ = proportion of the span, in metres, measured as shown in Fig. 11.2.7. The depth and face area over the remainder of the span is assumed to be constant<br>$p$ = minimum design pressure, in kN/m$^2$, acting on the hatch covers as defined in Table 11.2.8<br>$Z_0$ = section modulus at mid-span, in cm$^3$<br>$Z_1$ = section modulus at supports, in cm$^3$<br>$C_H = 1 + \dfrac{8\alpha_H{}^3 (1 - \beta_H)}{0{,}2 + 3\sqrt{\beta_H}}$<br>$K_H = 1 + \dfrac{3{,}2\alpha_H - \gamma_H - 0{,}8}{7{,}0\gamma_H + 0{,}4}$<br>but not less than 1,0. To be specially considered when discontinuities in area of face material occur<br>$\alpha_H = \dfrac{l_1}{l_0}$ $\quad\beta_H = \dfrac{I_1}{I_0}$ $\quad\gamma_H = \dfrac{Z_1}{Z_0}$ | $Z_0 = \dfrac{p\, s\, l_0{}^2 K_H k}{K_1}$ cm$^3$<br>$I_0 = \dfrac{p\, s\, l_0{}^3 C_H}{C_1}$ cm$^4$<br>$A_S = \dfrac{0{,}01282 p\, s\, l_0}{\sigma_o}$ cm$^2$<br>NOTE<br>Where the ends of the secondary panel stiffeners are effectively bracketed or continuous, the values of modulus and inertia of the secondary panel stiffeners may be reduced respectively by 33% and 80%. |

## ■ Section 3

## Hatch beams and wood covers

### 3.1 Portable hatch beams

*3.1.1* The section modulus and moment of inertia of portable web plate beams stiffened at their upper and lower edges by continuous flat bars are to satisfy the requirements of ~~2.2.1~~ 2.17 for pontoon covers. Alternatively, direct calculations may be used, provided the requirements of ~~2.2.2~~ 2.17 for pontoon covers are complied with.

### 3.2 Wood covers

*3.2.1* Wood covers are to have a finished thickness of not less than 60 mm in association with an unsupported span of not more than 1,5 m. Where the ‘tween deck height ~~as specified in 1.2.1~~, measured vertically on the centreline of the ship from ‘tween deck to underside of the hatch cover stiffeners on deck above, exceeds 2,6 m, the thickness of the wood covers is to be increased at the rate of 16,5 per cent per metre excess in ‘tween deck height.

## ■ Section 4

## Hatch cover securing arrangements and tarpaulins

### 4.2 Steel covers – Clamped and gasketed

*4.2.2* Where steel hatch covers are fitted to hatch openings on weather decks, the arrangements are to be such that weathertightness can be maintained. A sufficient number of securing devices is to be provided at each side of the hatch cover, considering the requirements of 2.9.4 to 2.9.6. This applies also to hatch covers consisting of several parts.

*4.2.3* The weight of the covers and weather loading may be transmitted to the ship’s structure by means of continuous steel to steel contact of the cover skirt plate with the ship’s structure in association with a maximum bearing pressure of 200 kgf/cm$^2$. Alternatively the weight may be transmitted by means of defined bearing pads. For covers loaded by containers or other cargo, the total load together with inertial forces generated by the ship’s motion, are to be transmitted by means of defined bearing pads only. ~~The maximum pressure on steel to steel bearing areas is not to exceed 600 kgf/cm$^2$. In cases where the pads are constructed of materials other than steel, the maximum bearing pressure should be based on the manufacturer’s recommendation.~~

~~For hatch cover roll/pitching stoppers intended to prevent horizontal movement of the cover panels, the force components parallel to the cover are to be taken as given in Table 14.8.2 in Ch 14,8:~~

~~and the permissible stresses are as follows:~~

| | |
|---|---|
| ~~Shear stress~~ | ~~0,4$\sigma_e$~~ |
| ~~Bending stress plus axial stress~~ | ~~0,67$\sigma_e$~~ |
| ~~Combined stress~~ | ~~0,86$\sigma_e$~~ |

~~where~~

~~$\sigma_e$ is the yield stress of the material.~~

~~In addition, the hatch side coamings and stays are to be of sufficient strength to accommodate the transverse inertial forces, see 5.2.12.~~

*4.2.4* For the design of the securing devices against shifting, the horizontal mass forces $F_h = m\,a$ are to be calculated with the following accelerations:

$a_x$ = 0,2 $g$ in longitudinal direction
$a_y$ = 0,5 $g$ in transverse direction
$m$ = sum of mass of cargo lashed on the hatch cover and mass of hatch cover.

*4.2.5* For the transmission of the support forces resulting from the load cases specified in 2.3 and of the horizontal mass forces specified in 4.2.4, hatch cover supports are to be provided, which are to be designed such that the nominal surface pressures do not, in general, exceed the following values:

$p_{n\,max}$ = $dp_n$, in N/mm$^2$
$d$ = 3,75 – 0,015$L$
$d_{max}$ = 3,0
$d_{min}$ = 1,0 in general
= 2,0 for partial loading conditions, *see* Pt 4, Ch 8, 11.2.4
$p_n$ = *see* Table 11.4.1

For metallic supporting surfaces not subjected to relative displacements, the nominal surface pressure applies:

$p_{n\,max}$ = $3p_n$, in N/mm$^2$

The supports are to be designed such that the permissible stresses according to 2.4.1 are not exceeded.

**Table 11.4.1 Permissible nominal surface pressure $p_n$**

| Support material | $p_n$ in N/mm$^2$ when loaded by | |
|---|---|---|
| | Vertical force | Horizontal force (on stoppers) |
| Hull structural steel | 25 | 40 |
| Hardened steel | 35 | 50 |
| Plastic materials on steel | 50 | — |

*4.2.6* Drawings of hatch cover supports which specify the permitted maximum pressure related to long-term stress, given by the material manufacturer, must be submitted.

*4.2.7* Where large relative displacements of the supporting surfaces of hatch cover supports are to be expected, the use of material having low wear and frictional properties is recommended. If necessary, sufficient abrasive strength may be shown by tests demonstrating an abrasion of support surfaces of not more than 0,3 mm per year in service, at a total distance of shifting of 15 000 m/year.

*4.2.8* The substructures of the hatch cover supports must be of such a design that a uniform pressure distribution is achieved. Irrespective of the arrangement of stoppers, the supports must be able to transmit the following force $P_h$ in the longitudinal and transverse direction:

$$P_h = \mu \frac{P_v}{\sqrt{d}}$$

where

$P_v$ = vertical supporting force
$\mu$ = frictional coefficient
= 0,5 in general

For non-metallic, low-friction support materials on steel, the friction coefficient may be reduced, but is not to be less than 0,35. The substructures are to be designed such that the permissible stresses according to 2.4.1 are not exceeded.

*4.2.9* For substructures and adjacent structures of supports subjected to horizontal forces $P_h$, as defined in 4.2.8, a fatigue strength analysis is to be carried out.

*4.2.10* Hatch covers are to be sufficiently secured against horizontal shifting. Stoppers are to be provided for hatch covers on which cargo is carried. The greater of the loads resulting from 2.3.3 and 4.2.4 is to be applied for the dimensioning of the stoppers and their substructures. The permissible stress in stoppers and their substructures in the cover and in the coamings is to be determined according to 2.4.1. In addition, the provisions in 4.2.5 are to be observed.

*Existing paragraphs* 4.2.4 *to* 4.2.6 *have been renumbered* 4.2.11 *to* 4.2.13.

~~4.2.7~~ *4.2.14* Drainage is to be arranged inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming; drain openings are to be provided at appropriate positions of the drain channels. This requirement need not be complied with for special ships carrying container cargoes when the requirements of ~~2.2.6~~ Pt 4, Ch 8,11 are satisfied.

~~4.2.8~~ *4.2.15* Where the arrangement includes continuous steel to steel contact between hatch cover and coaming or between hatch cover and ship structure or at cross-joints, drainage on both sides of the gasket is to be provided.

~~4.2.9~~ *4.2.16* Drain openings are to be arranged at the ends of drain channels and are to be provided with ~~effective means~~ non-return valves for preventing ingress of water from outside.

The following requirements are to be complied with:

(a) If manufactured from steel, the minimum drain pipe wall thickness is to be not less than ~~5,5~~ 4,5 mm.
(b) If not manufactured from steel, details of the drain, including the material specification, method of manufacture and details of any tests carried out, are to be submitted for consideration.
~~(c) Where the drains are not provided with an approved automatic means of preventing water entering the hold, the drains are to be capable of being closed by a screw plug or cap which is to be attached by a strong keep chain to the drain.~~
~~(d)~~ (c) The drains are to be securely attached to the hatch coaming and adequately protected if in an exposed position.

~~(c)~~ (d) When the drain is fitted to a hold also designed to carry liquids, a shut-off valve is to be incorporated into the assembly.

(e) Drain openings in hatch coamings are to be arranged with sufficient distance to areas of stress concentration (e.g., hatch corners, transitions to crane posts).

*Existing paragraphs* 4.2.10 *and* 4.2.11 *have been renumbered* 4.2.17 *and* 4.2.18.

*~~4.2.12~~ 4.2.19* The net sectional area of each securing device is to be not less than:

$$A = \frac{1{,}4 S_1 W_1}{50f} \text{ cm}^2 \quad \left( \frac{1{,}4 S_1 W_1}{5{,}1f} \text{ cm}^2 \right)$$

where

$$f = \left( \frac{\sigma_c}{235} \right)^e$$

$S_1$ = spacing ~~or~~ between securing devices, in metres, not to exceed 6 m and not to be taken less than 2 m

$W_1$ = the gasket loading per unit length, in N/cm (kgf/cm), but not less than 50 N/cm (5,1 kgf/cm)

$\sigma_c$ = specified minimum upper yield stress in N/mm$^2$ (kgf/mm$^2$) of the steel used for cleats or securing devices, to be taken not greater than 70 per cent of the ultimate tensile strength

$e$ = 0,75 for $\sigma_c \geq 235$ (24)

= 1,0 for $\sigma_c < 235$ (24).

*~~4.2.13~~ 4.2.20* Rods or bolts are to have a ~~net~~ gross diameter not less than 19 mm for hatchways exceeding 5 m$^2$ in area.

*Existing paragraphs* 4.2.14 *to* 4.2.22 *have been renumbered* 4.2.21 *to* 4.2.29.

*~~4.2.23~~ 4.2.30* Upon completion of installation of hatch covers, a hose test with a pressure of water as specified in Table 1.8.1 in Chapter 1 is to be carried out. Alternative methods of tightness testing will be considered. This does not apply to covers with reduced securing arrangements as specified in ~~2.2.6~~ Pt 4, Ch 8,11.

*Existing paragraphs* 4.2.24 *and* 4.2.25 *have been renumbered* 4.2.31 *and* 4.2.32.

*~~4.2.26~~ 4.2.33* The spacing and size of securing devices in hatch covers for holds which may be flooded and used for ballast tanks and holds in OBO, ore or oil and similar types of ship are to correspond to the reaction forces at the cover edges found by calculation~~, see 2.2.4~~. The loading is to be as required by Pt 4, Ch 7,12.4.1(c).

The permissible ~~stresses are~~ stress in the securing devices is not to exceed the following~~ values~~:

~~(a) For rod and bolt type; a tensile stress of 120*f* N/mm$^2$ (12,2*f* kgf/mm$^2$) in way of the thread or in way of the minimum section clear of the thread whichever is the smaller section.~~

~~(b) For devices other than rod and bolt type:~~

~~$\sigma$ = 120$f$ N/mm$^2$ (12,2$f$ kgf/mm$^2$)~~

~~$\sigma_e$ = 150$f$ N/mm$^2$ (15,3$f$ kgf/mm$^2$)~~

~~$\tau$ = 80$f$ N/mm$^2$ (8,2$f$ kgf/mm$^2$)~~

$\sigma_e$ = $0{,}9 \times 235\, f$ N/mm$^2$

where

$f$ = material factor as defined in ~~4.2.12~~ 4.2.19

$\sigma$ = bending stress in N/mm$^2$ ~~(kgf/mm$^2$)~~

$\sigma_e$ = equivalent stress, in N/mm$^2$ ~~(kgf/mm$^2$)~~

= $\sqrt{(\sigma^2 + 3\tau^2)}$

$\tau$ = shear stress in N/mm$^2$.

*Existing paragraphs* 4.2.27 *and* 4.2.28 *have been renumbered* 4.2.34 *and* 4.2.35.

*Existing paragraph* 4.2.29 *has been deleted.*

*4.2.36* The material and weld specifications of stoppers and securing devices are to be shown in the drawings of the hatch covers.

*4.2.37* Securing devices of special design in which significant bending or shear stresses occur may be designed as anti-lifting devices according to Pt 4, Ch 8,11.2.5. The packing line pressure, as defined in 4.2.12, multiplied by the spacing between securing devices, as defined in 4.2.12, is to be applied as design load.

### 4.4 Packing material

*4.4.1* Packing material is to be suitable for all expected service conditions of the ship and is to be compatible with the cargoes to be transported. The packing material is to be selected with regard to dimensions and elasticity in such a way that expected deformations can be carried. Forces are to be carried by the steel structure only.

*4.4.2* Packing material is to be compressed so as to give the necessary tightness effect for all expected operating conditions. Special consideration will be given to the packing arrangement in ships with large relative movements between hatch covers and coamings or between hatch cover sections.

## ■ *Section 5*
## Hatch coamings

### 5.2 Construction

~~*5.2.1* Vertical coamings are to have a thickness, *t*, in mm not less than the greater of the following:~~

~~(a) $t$ = 0,008$H_e$-$\sqrt{k}$ + 1,0 mm~~

~~(b) $t$ = 12,0 mm where $L \geq 60$ m, and not less than 9 mm where $L \leq 30$ m~~

~~Intermediate values are to be obtained by interpolation.~~

~~In addition, for ships without a forecastle or breakwater the scantlings of the coamings for Number 1 cargo hatchway are not to be less than that required by Ch 8,2 for front bulkhead of deckhouse at that position.~~

*Existing paragraphs* 5.2.2 *to* 5.2.4 *have been renumbered* 5.2.1 *to* 5.2.3.

~~5.2.5~~ 5.2.4 The scantlings and arrangements of ~~vertical cargo hatch coamings more than 900 mm in height and of cargo~~ hatch coamings acting as girders will be specially considered. The coamings are to be arranged with intermediate continuous horizontal stiffeners supported by the bracket stays. ~~In such cases the coamings are to have a thickness as required by 5.2.1 taking $H_e$, in mm, as the vertical distance between the continuous longitudinal stiffeners.~~

~~5.2.6~~ 5.2.5 Sloped cargo hatch coamings will be specially considered. In general, the sloped coaming arrangement is to be restricted to the hatch side coamings with vertical coamings at the ends. The sloped coaming is not to have a knuckle and the angle to the vertical is not to exceed 30°. The scantlings are to be in accordance with ~~5.2.1 to 5.2.3 inclusive~~ 5.2.1, 5.2.2 and 5.3, except that the end coamings are to be increased by 20 per cent for a distance of 0,15*b* from the side coamings where *b* is the width of the hatchway at the deck. Particular care is to be taken where the proposed loadings exceed ~~the loadings~~ those given in ~~1.2.1(a)~~ 2.3 and Ch 3,5, and where the coamings are not in alignment with the topside tank vertical strake in bulk carriers.

*Existing paragraphs* 5.2.7 *to* 5.2.13 *have been renumbered* 5.2.6 *to* 5.2.12.

*5.2.13* Material for hatch coamings is to be steel, according to the requirements for ship's hull. Alternative materials will be subject to special consideration.

*5.2.14* Secondary stiffeners of hatch coamings are to be continuous over the breadth and length of hatch coamings.

*5.2.15* Longitudinal hatch coamings with a length exceeding 0,1*L* m are to be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets they are to be connected to the deck by full penetration welds of minimum 300 mm in length.

*5.2.16* Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions. Structures under deck are to be checked against the load transmitted by coaming stays.

*5.2.17* On ships carrying cargo on deck, such as timber, coal or coke, coaming stays are to be spaced not more than 1,5 m apart.

*5.2.18* Coaming plates are to extend to the lower edge of the deck beams; they are to be flanged or fitted with face bars or half-round bars. Fig.11.5.2 gives an example.

### 5.3 Strength criteria

*5.3.1* The strength requirements in this Section are applicable to hatch coamings of stiffened plate construction.

*5.3.2* The local net plate thickness of weather deck hatch coamings is not to be less than the larger of the following values:

$$t = 0{,}0142s\sqrt{\frac{p_A}{0{,}95\,\sigma_o}} \quad \text{in mm}$$

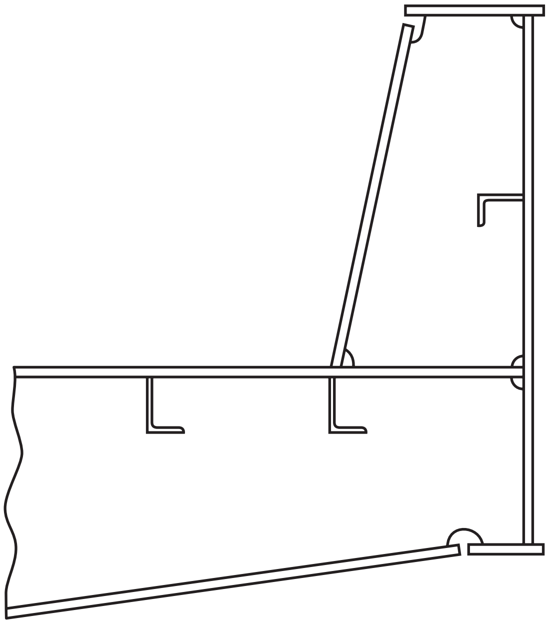


**Fig. 11.5.2**
**Example for the extent of coaming plates**

$$t_{min} = 6 + \frac{L_1}{100} \quad \text{in mm}$$

where
$s$ = stiffener spacing, in mm
$L_1$ = $L$ need not be taken greater than 300 metres
$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3
Longitudinal strength aspects are to be observed.

*5.3.3* Secondary stiffeners of coamings must be continuous at the coaming stays. For stiffeners with both ends constrained, the elastic net section modulus $Z$ in cm$^3$ and net shear area $A_S$ in cm$^2$, calculated on the basis of net thickness, are not to be less than:

$$Z = \frac{0{,}083}{\sigma_o} s\, l^2\, p_A \text{ cm}^3$$

$$A_s = \frac{0{,}01s\, l\, p_A}{\sigma_o} \text{ cm}^2$$

where
$l$ = secondary stiffener span, in metres, to be taken as the spacing of coaming stays
$s$ = stiffener spacing in mm
$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.4* For sniped stiffeners at coaming corners, section modulus and shear area at the fixed support are to be increased by 35 per cent. The gross thickness of the coaming plate at the sniped stiffener end is not to be less than:

$$t = 19{,}6\sqrt{\frac{0{,}001s\, p_A\,(l - 0{,}0005\, s)}{\sigma_o}} \quad \text{n mm}$$

where
$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.5* Coaming stays are to be designed for the loads transmitted through them, and permissible stresses according to 2.4.1.

*5.3.6* The net section modulus $Z$ of coaming stays, with a height of $h_s < 1{,}6$ m and which are to be designed for the load $p_A$, is not to be less than:

$$Z = \frac{526}{\sigma_o} e\, h_s^2\, p_A \quad \text{in cm}^3$$

where
$e$ = spacing of coaming stays, in metres
$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.7* Coaming stays of coamings having a height of 1,6 m or more are to be designed using direct calculations under consideration of the permissible stresses according to 2.4.1. The effective breadth of the coaming plate is not to be larger than the effective plate breadth according to 2.10.2.

*5.3.8* Coaming stays are to be supported by appropriate substructures. Face-plates may be included in the calculation only if an appropriate substructure is provided and welding ensures an adequate joint.

*5.3.9* The web gross thickness of coaming stays at the root point is not to be less than:

$$t_w = \frac{2\, e\, h_s\, p_A}{\sigma_o\, h_w} + t_c$$

where
$h_w$ = web height of coaming stay at its lower end, in metres
$t_c$ = corrosion addition, in mm, according to 1.1.13
$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.10* Webs of coaming stays are to be connected to the deck by fillet welds on both sides with a throat thickness of $a = 0{,}44 t_w$.

*5.3.11* For coaming stays which transfer friction forces at hatch cover supports, sufficient fatigue strength is to be verified, *see* 4.2.5 to 4.2.8.

*5.3.12* Hatch coamings which are part of the longitudinal hull structure are to be designed according to the requirements for longitudinal strength in Pt 3, Ch 4.

*5.3.13* For structural members welded to coamings and for cut-outs in the top of coamings, sufficient fatigue strength is to be verified.

*Existing sub-Sections* 5.3 *and* 5.4 *have been renumbered* 5.4 *and* 5.5.

### ~~5.4~~ 5.5 Loading in excess of Rule requirements

*~~5.4.1~~ 5.5.1* For weather deck hatch side coamings forming part of a hatch side girder subjected to loading exceeding that defined in ~~1.2.1~~ 2.3, *see* Pt 4, Ch 1,4.

# Part 4, Chapter 7

# Bulk Carriers

**Effective date 1 July, 2012**

## ■ *Section 12*
## Steel hatch covers

### 12.1 General

*12.1.1* These requirements apply to hatch covers on exposed decks in Position 1, *see* Pt 3, Ch 1,6.5.1, and are in addition to the ~~requirements of Pt 3, Ch 11,2.~~ following requirements:

(a) Pt 3, Ch 11,4.2.14, 4.2.16, 4.2.17, 4.2.25, 4.2.27, and 4.2.29 to 4.2.33.

(b) Pt 3, Ch 11,4.2.5 for the vertical weather pressure load case and cargo load, if carried on the hatch covers.

NOTE
When cargo is carried on the hatch covers, Pt 3, Ch 11,4.2.8 to 4.2.10 are also to be complied with. Cargo loads are to be in accordance with Pt 3, Ch 11,2.3.4 and 2.3.5. Pt 4, Ch 8,11.2 is to be considered for compliance with Pt 3, Ch 11, 2.4.1, 2.4.2, 2.5.1, 2.8.1, 2.8.4, 2.8.5, 2.9.1 and 2.9.2. The vertical weather design load needs not to be combined with the cargo load.

(c) For hatch covers subject to wheel loading or helicopter landing, Pt 3, Ch 9,3 and Ch 9,5 are to be complied with.

### 12.3 Closing arrangements

*12.3.10* Hatch covers are to be effectively secured, by means of stoppers, against transverse and longitudinal forces (acting on the forward end) arising from a pressure of 175 kN/m$^2$.

### 12.4 Load model

*12.4.1* *(Part only shown)*
The pressure, $p$, in kN/m$^2$, acting on the hatch covers is given by:

(c) For weather deck covers for holds which may be flooded and used as ballast tanks and holds in OBO, ore or oil and similar types of ship, the pressure $p$, in kN/m$^2$, due to the internal load for a member and position under consideration is to be taken as:

$$p = 5{,}53 Y \sin q \qquad \text{kN/m}^2$$

where

$$\sin q = \left(0{,}45 + \frac{L}{10B}\right)\left(0{,}54 - \frac{L}{1270}\right)$$

$q$ = roll angle, in degrees, but need not exceed 25° and is not to be taken as less than 22°

$Y$ = transverse distance, in metres, from the side coaming at the coaming top to the member and position under consideration. Both sides of roll are to be considered.
In way of holds for oil cargo, a load equivalent to the inert gas pressure is to be applied over the full breadth of the cover and added to the load corresponding to the liquid pressure. However, where the rolling angle has been determined by direct calculations, the load may be derived accordingly.

### 12.10 Hatch cover plating

*12.10.3* The biaxial compressive stress in the hatch cover panels, when calculated by means of FEM shell element model ~~will be specially considered~~, is to comply with Pt 3, Ch 11,2.11.2, using $S = 1{,}25$.

## ■ *Section 13*
## Hatch coamings

### 13.1 General

*13.1.1* The height and construction of forward and side hatch coamings are to comply with the following requirements. All hatch coamings are to comply with the requirements of ~~Pt 3, Ch 11,5~~ Pt 3, Ch 11,5.1.1, 5.1.3, 5.2.1, 5.2.2, 5.2.4 to 5.2.12, 5.2.16 to 5.2.18 and 5.4.1.

# Part 4, Chapter 8
# Container Ships

**Effective date 1 July, 2012**

## ■ *Section 10*
## Hatch coamings and support for hatch covers

### 10.1 Hatch coamings

*10.1.1* Scantlings of hatch coamings are to comply with Pt 3, Ch 11,5 in addition to the requirements of this Section. ~~For ships where the base of the hatch coaming is more than one standard superstructure height (as defined in Pt 3, Ch 8,1.3.2) above the freeboard deck a reduction of the minimum thickness by 1 mm will be permitted.~~

## ■ *Section 11*
## Hatch covers

### 11.1 General

~~*11.1.2* For the purposes of this Section, hatch covers are categorised into two types as indicated in Table 8.11.1.~~

~~**Table 8.11.1 Definitions of hatch cover types**~~

| ~~Type~~ | ~~Description~~ |
|---|---|
| ~~I~~ | ~~All edges of the hatch cover are supported by external structures~~ |
| ~~II~~ | ~~One or more edges of the hatch cover are self-supporting~~ |

*Existing paragraphs* 11.1.3 *and* 11.1.4 *have been renumbered* 11.1.2 *and* 11.1.3.

~~*11.1.5*~~ *11.1.4* Local stiffening is to be arranged below container corners. The substructures of container foundations are to be designed for cargo and container loads according to Pt 3, Ch 11,2.3, applying the permissible stresses according to Pt 3, Ch 11,2.4.1.

### 11.2 Direct calculations

~~*11.2.2* The load cases, method of loading and acceptance criteria are indicated in Tables 8.11.2 and 8.11.3.~~

*11.2.2* Where containers are stowed on hatch covers, the following loads due to heave, pitch, and the ship's rolling motion are to be considered, *see* Fig. 8.11.1:

$$A_z = 9{,}81\,\frac{M}{2}\,(1 + a_v)\left(0{,}45 - 0{,}42\,\frac{h_m}{b}\right)\ \text{kN}$$

$$B_z = 9{,}81\,\frac{M}{2}\,(1 + a_v)\left(0{,}45 + 0{,}42\,\frac{h_m}{b}\right)\ \text{kN}$$

$$B_y = 2{,}4M\ \text{kN}$$

The loads due to single forces resulting from heave and pitch are also to be considered, as defined in Pt 3, Ch 11,2.3.5, where

$a_v$ = acceleration addition according to Pt 3, Ch 11,2.3.4
$b$ = distance between foot points, in metres
$h_m$ = designed height of centre of gravity of stack above hatch cover supports, in metres
$A_z$, $B_z$ = support forces in z-direction at the forward and aft stack corners, in kN
$B_y$ = support force in y-direction at the forward and aft stack corners, in kN
$M$ = maximum designed mass of container stack, in $t$

~~**Table 8.11.2 Loadcases for direct calculations**~~

| Application | Loadcase | Applied loading |
|---|---|---|
| Type I, II | Loadcase 1<br>UDL Weather Load | Uniform distributed weather loading as defined in Pt 3, Ch 11,1.2 and 2.2.5 |
| Type I, II | Loadcase 2<br>Container Load - Static Upright | Container loads normal to the hatch cover top plating, *see* Fig. 8.11.1<br>$F_a, F_b = \frac{W_T}{4}$ |
| Type II | Loadcase 3<br>Container Load - Static Heeled | Static container loads normal to the hatch cover top plating, *see* Fig. 8.11.1<br>$F_a = 0{,}25\cos\theta\, W_T + 0{,}5\, \frac{\sin\theta}{b_1} \sum_{i=1}^{n} (W_i Z_i)$<br>$F_b = 0{,}25\cos\theta\, W_T - 0{,}5\, \frac{\sin\theta}{b_1} \sum_{i=1}^{n} (W_i Z_i)$ |

Symbols

$F_a$ and $F_b$ = corner forces acting on a hatch cover at each end of the container
$b_1$ = distance between the twistlocks
$n$ = number of containers in stack, *see* Note
$W_i$ = specified weight of each individual container, *see* Note
$W_T$ = total stack weight
$Z_i$ = lever to vertical centre of gravity of each container above base of stack. Vertical centre of gravity is assumed one third of the container depth above the base of the container
$\theta$ = roll angle of 30°

NOTE
$W_i$ and $n$ are to be specified based on the most onerous stack weight combination.

~~**Table 8.11.3 Assessment criteria for direct calculations**~~

| Loadcase | Permissible bending stress N/mm$^2$ (kgf/mm$^2$) | Permissible shear stress N/mm$^2$ (kgf/mm$^2$) | Permissible deflection | Buckling requirement |
|---|---|---|---|---|
| 1 | Pt 3, Ch 11, Table 11.2.3 for uniform distributed (weather load) | | | |
| 2 | 117,7/*k*<br>(12,0/*k*) | 68,7/*k*<br>(7,0/*k*) | $0{,}0035 l_o$ | Pt 3, Ch 11, Table 11.2.1<br>*See* Note 1 |
| 3 | 164,5/*k*<br>(16,8/*k*) | 98,7/*k*<br>(10,1/*k*) | *See* Notes 2 and 3 | |

Symbols

$l_o$ = unsupported span, in metres as shown in Fig. 11.1.2 in Pt 3 Ch 11.

NOTES
1. In using Table 11.2.1 in Pt 3, Ch 11, the ratio $\sigma_c/\sigma_b$(or $\sigma_{ac}/\sigma_b$) is not to be less than 1,15 where the primary bending stress acts on either the longer or shorter panel edge.
2. The weathertightness is to be maintained where appropriate.
3. When the deflection exceeds $0{,}0045 l_o$, ultimate strength of the hatch cover is to be specially considered.
4. No allowance is to be given for the effect of cargo securing loads.

For $M$ and $h_m$, it is recommended to apply those values which are used for the calculations of cargo securing (container lashing). If different assumptions are made for $M$ and $h_m$, the designer is to ensure that, in the calculation model, the hatch cover structure is not loaded by less than those values recommended.
When the strength of the hatch cover structure is assessed by FE analysis according to the ShipRight procedure *Assessment of Steel Hatch Covers using Finite Element Analysis*, $h_m$ may be taken as the designed height of centre of gravity of stack above the hatch cover top plate. Values of $M$ and $h_m$ applied for the assessment of hatch cover strength are to be shown in the drawings of the hatch covers.

*11.2.3* The forces acting on hatch covers when container stacks are secured to lashing bridges or carried in cell guides will be specially considered.

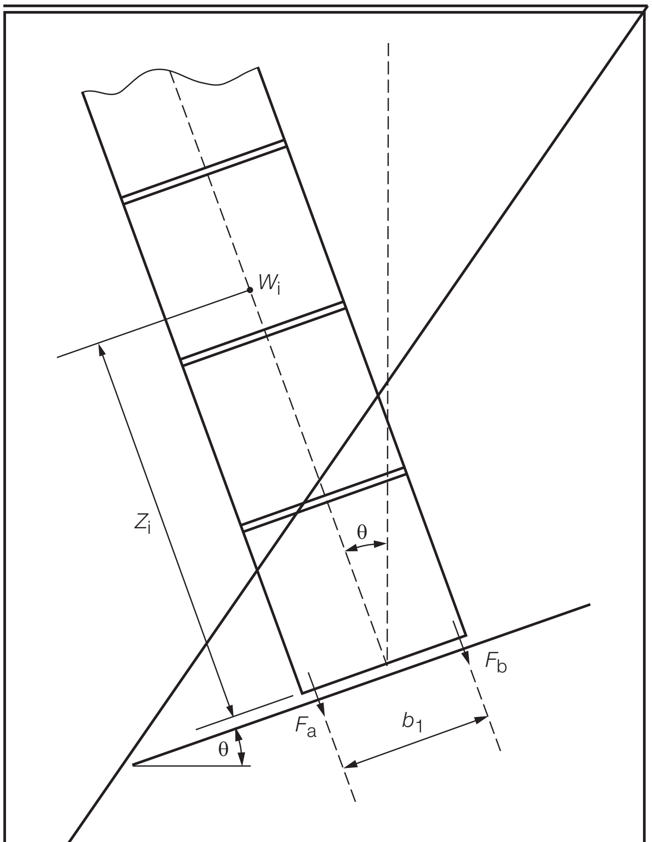


Fig. 8.11.1
**Nomenclature for container loads**

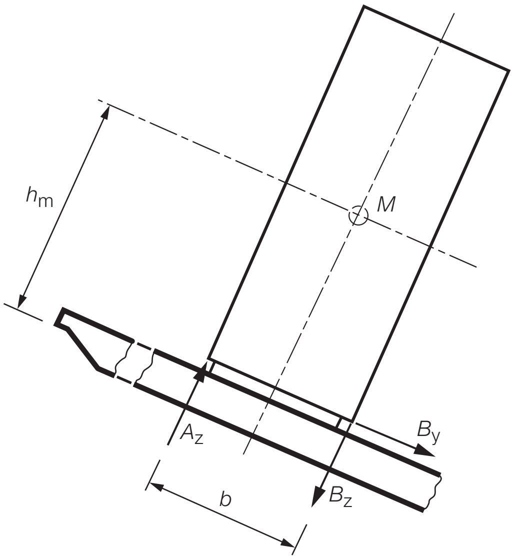


Fig. 8.11.1
**Forces due to container loads**

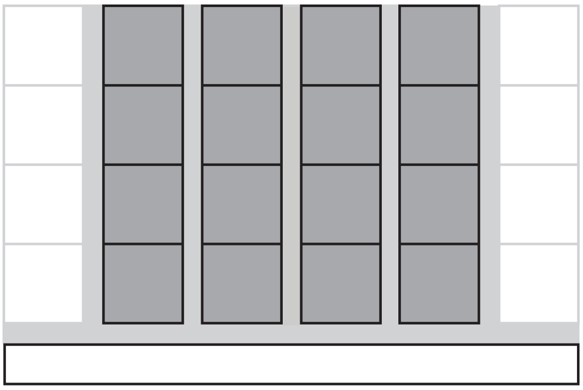


Fig. 8.11.2
**Partial loading of a container hatch cover**

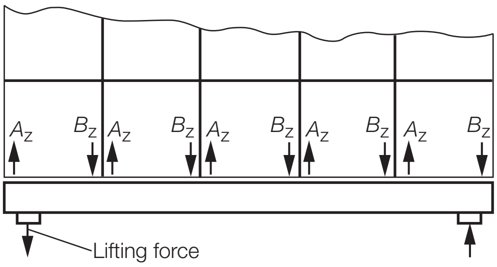


Fig. 8.11.3
**Lifting forces at a hatch cover**

*11.2.4* A load case with partial non-homogeneous loading is also to be considered, e.g., where specified container stack places are empty. This may be evaluated using a simplified approach, where the hatch cover is loaded without the outermost stacks, *see* Fig. 8.11.2.

*11.2.5* The securing devices of hatch covers, onto which cargo is to be lashed, are to be designed for the lifting forces resulting from loads according to 11.2.2, *see* Fig. 8.11.3. Unsymmetrical loadings, which may occur in practice, are to be considered. Under these loadings, the equivalent stress in the securing devices is not to exceed:

$$\sigma_v = \frac{150}{k_1} \text{ in N/mm}^2$$

Special consideration may be given for the omission of antilifting devices for non-weathertight hatch covers.

*11.2.6* Where hatch covers are arranged for carrying containers and mixed stowage is allowed, i.e., a 40' container stowed on top of two 20' containers, particular attention is to be paid to the deflections of hatch covers. Furthermore, the possible contact of deflected hatch covers with in-hold cargo is to be considered.

### ~~11.3 Omission of hatch cover gaskets~~

~~*11.3.1* For ships which have hatch covers in the position defined in Pt 3, Ch 11,2.2.5, special consideration will be given to the omission of gaskets and a reduction in number of cleats. The agreement of the National Authority will be required in such cases.~~

~~*11.3.2* The horizontal gap between panels is not to exceed 50 mm.~~

### 11.3 Dispensation of weathertight gaskets

*11.3.1* For hatch covers of cargo holds solely for the transport of containers, upon request by the Owners and subject to compliance with the requirements of this Section, the fitting of weathertight gaskets according to Pt 3, Ch 11,4.4 may be dispensed with.

*11.3.2* The hatchway coamings are not to be less than 600 mm in height.

*11.3.3* The exposed deck on which the hatch covers are located is situated above a depth $H$(x). $H$(x) is to be shown to comply with the following criteria:

$$H(\mathrm{x}) \geq T_{\mathrm{fb}} + f_{\mathrm{b}} + h, \text{ in metres}$$

where

$T_{\mathrm{fb}}$ = draught, in metres, corresponding to the assigned summer load line

$f_{\mathrm{b}}$ = minimum required freeboard, in metres, determined in accordance with ICLL Reg. 28 as modified by further regulations, as applicable

$h$ = 4,6 m for $\dfrac{x}{L} \leq 0{,}75$

= 6,9 m for $\dfrac{x}{L} > 0{,}75$.

*11.3.4* Labyrinths, gutter bars or equivalents are to be fitted proximate to the edges of each panel in way of the coamings. The clear profile of these openings is to be kept as small as possible.

*11.3.5* Where a hatch is covered by several hatch cover panels, the clear opening of the gap in between the panels is to be not wider than 50 mm.

*11.3.6* The labyrinths and gaps between hatch cover panels shall be considered as unprotected openings with respect to the requirements of intact and damage stability calculations.

*11.3.7* Bilge alarms are to be provided in each hold fitted with non-weathertight covers.

*11.3.8* Furthermore, Chapter 3 of IMO MSC/Circ.1087 is to be referred to concerning the stowage and segregation of containers containing dangerous goods.

# Part 4, Chapter 11

# Ore Carriers

**Effective date 1 July, 2012**

## ■ *Section 4*

## Hull envelope plating

### 4.3 Hatchways

*4.3.1* The scantlings of the ~~cargo hold hatch coamings are to comply with Pt 3, Ch 11,5 and the~~ cargo hold hatch covers are to comply with Pt 3, Ch 11,2 and Pt 4, Ch 7,12.

### 4.4 Hatch coamings

*4.4.1* The height and construction of hatch coamings are to comply with ~~Pt 3, Ch 11,5 and~~ Pt 4, Ch 7,13.

## Cross-references

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Ships.

## Part 1, Chapter 2

| | |
|---|---|
| *2.3.14* | *Reference* 1.6, Pt 3, Ch 2 *now reads* Pt 4, Ch 7,1.4<br>*Reference* 1.6, Pt 3, Ch 2 *now reads* Pt 4, Ch 7,1.5 |

## Part 3, Chapter 2

| | |
|---|---|
| *1.1.3* | *Reference* 2.3 *has been deleted* |

## Part 5, Chapter 2

| | |
|---|---|
| *18.3.1(m)* | *Reference* 6.3.1 *now reads* 10.3.1 |
| *7.6.7* | *Reference* 8.4 *now reads* 16.4 |

## Part 5, Chapter 21

| | |
|---|---|
| *1.3.5* | *Reference* Pt 6, Ch 1,2.10.21 *now reads* Pt 6, Ch 1,3.6.3 |

## Part 6, Chapter 1

| | |
|---|---|
| *1.3.3* | *Reference* Table 1.3.11 *now reads* Table 14.12.4 in Pt 5, Ch 14 |
| *2.4.3* | *Reference* 3.1.4 *now reads* Pt 5, Ch 14, 12.1.4 |

## Part 6, Chapter 2

| | |
|---|---|
| *17.1.2* | *Reference* 10.6.4 *now reads* 11.6.4 |

## Part 7, Chapter 12

| | |
|---|---|
| *Table 12.3.5* | *Reference* Pt 6, Ch 1,3.1.5 *now reads* Pt 5, Ch 2,7.5.5 |

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# Rules and Regulations for the Classification of Ships, July 2012

# Supplement to Notice No. 1

Issue date: July 2012

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# RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, *July 2012*

## Supplement to Notice No. 1

This Supplement contains the amendments shown in Notice No. 1
as a complete Chapter for ease of presentation.

| ***Part*** | ***Chapter*** | ***Amended Sections*** | ***Effective date*** |
|---|---|---|---|
| 3 | 11 | 1, 2, 3, 4, 5 | 1 July 2012 |

The *Rules and Regulations for the Classification of Ships, July 2012* are to be read in conjunction with Notice No. 1. The status of the Rules is now:

| | | |
|---|---|---|
| Rules for Ships | Effective date: | July 2012 |
| Notice No. 1 | Effective date: | 1 July 2012 |

# Closing Arrangements for Shell, Deck and Bulkheads

*Section*

*1* **General**

*2* **Steel hatch covers**

*3* **Hatch beams and wood covers**

*4* **Hatch cover securing arrangements and tarpaulins**

*5* **Hatch coamings**

*6* **Miscellaneous openings**

*7* **Tanker access arrangements and closing appliances**

*8* **Side and stern doors and other shell openings**

*9* **Watertight doors in bulkheads below the freeboard deck**

*10* **External openings and openings in watertight bulkheads and internal decks in cargo ships**

## *Section 1*
## General

### 1.1 Application

*1.1.1* This Chapter applies to all ship types detailed in Part 4, unless otherwise stated, with the exception of Sections 1 to 5 which are not applicable to Bulk Carriers with a **CSR** notation, *see* Pt 1, Ch 2,2.3. Additional provisions regarding access arrangements for oil tankers and chemical carriers are contained in Pt 4, Ch 9, Ch 10 and the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquid Chemicals in Bulk* (hereinafter referred to as the Rules for Ships for Liquid Chemicals), respectively.

*1.1.2* Requirements are given for steel and wooden hatch covers, securing arrangements, tarpaulins, coamings and side shell doors for main openings, also closing arrangements for other miscellaneous openings.

*1.1.3* Where relevant, the contents of this Chapter conform with the requirements of the *International Convention on Load Lines, 1966*. Attention should, however, be given to any additional Statutory Requirements of the National Authority of the country in which the ship is to be registered and to the relevant regulations of the *International Convention for the Safety of Life at Sea, 1974* and applicable amendments.

*1.1.4* For the purpose of this Chapter the basic types of ships are those defined in the *International Convention on Load Lines, 1966,* namely:

| | |
|---|---|
| Type ‘A’ | Ships designed solely for the carriage of liquid cargoes. |
| Type ‘B’ | Cargo ships, other than Type ‘A’, with steel weathertight hatch covers. |
| Type ‘B-100’ | Cargo ships of type ‘B’ with reduced free-boards on account of their ability to survive a stipulated damage. |
| Type ‘B-60’ | |
| Type ‘B +’ | Cargo ships with increased freeboard on account of hatch cover arrangements. |

*1.1.5* The type of hatch covers on the weather decks of the basic ship types defined in 1.1.4 are detailed below and may be used in the types of ships as indicated in Table 11.1.1:

(a) Steel plated cargo hatch covers stiffened by webs or stiffeners and secured by clamping devices. Weather-tightness to be achieved by means of gaskets. Hatch covers used for holds containing liquid cargoes are included in this category.

(b) Steel plated cargo hatch pontoon covers having interior webs and stiffeners extending for the full width of the hatchway. A pontoon cover is defined as a portable cover, secured weathertight by tarpaulins and battening devices.

(c) Hatch covers of wood or steel used in conjunction with portable beams. Weathertightness to be obtained by tarpaulins.

(d) Access hatch covers for cargo oil tanks and adjacent spaces. The hatch covers are to be of steel and gasketed.

(e) Access hatch covers other than (d). For Type ‘A’, Type ‘B-100’ and Type ‘B-60’ ships, the covers are to be of steel, and weathertightness is to be achieved by means of gaskets.

**Table 11.1.1 Covers associated with ship types**

| Type of cover | Type of ship | | | | |
|---|---|---|---|---|---|
| | ‘A’ | ‘B-100’ | ‘B-60’ | ‘B’ | ‘B +’ |
| (a) | – | X | X | X | X |
| (b) | – | – | – | X | X |
| (c) | – | – | – | – | X |
| (d) | X | X | X | Not applicable | |
| (e) | X | X | X | X | X |

*1.1.6* The positions of hatches on weather decks are defined in Ch 1,6.5.

*1.1.7* ‘Tween deck hatch covers may be any of the types defined in 1.1.5, but need not be weathertight unless fitted to deep tanks or water ballast holds or compartments, in which case the covers are to be of type (a) and oiltight or watertight as appropriate.

*1.1.8* The scantlings specified in the following Sections are applicable to covers of mild steel or higher tensile steel. Where other materials are used, equivalent scantlings are to be provided. The scantlings apply basically to rectangular covers, with the stiffening members arranged primarily in one direction and carrying a uniformly distributed load. The covers are assumed to be simply supported. Where covers are stiffened by a grillage formation, and also where point loads are applied to any type of cover, the scantlings are to be determined from direct calculations.

*1.1.9* In the case of flush hatch covers or of covers on coamings of lesser height than required by 5.1.1, their scantlings, the securing and sealing arrangements and the drainage of gutterways will be specially considered.

*1.1.10* The scantlings of hatch covers need to be increased only if the loading exceeds that given in 2.3. The scantlings of the surrounding deck structure are to be sufficient to support this loading. Heavier loading may be permitted only if the scantlings of the cover are capable of withstanding this increased loading, satisfying the stress and deflection criteria given in this Chapter. The deck structure is also to be capable of withstanding this increased loading.

*1.1.11* Where timber cargo is to be carried on the hatch covers the requirements of Ch 9,2.7 are to be satisfied in addition to the requirements of this Chapter.

*1.1.12* Where hatchways are trunked through one or more 'tween decks, and hatchway beams and covers are dispensed with at the intermediate decks, the hatchway beams, coamings and covers immediately below the trunk are to be adequately strengthened. Plans are to be submitted for approval.

*1.1.13* The net plate thickness, $t_{net}$, is the calculated minimum thickness of the plating and stiffeners. The required thickness is the net thickness plus a corrosion addition, $t_c$, given in Table 11.1.2.

**Table 11.1.2 Corrosion addition $t_c$**

| Application | Structure | $t_c$, in mm |
|---|---|---|
| Weather deck hatches of container ships, car carriers, paper carriers, passenger vessels | Hatch covers | 1,0 |
| | Hatch coamings | 1,0 |
| Weather deck hatches of all other ship types except bulk carriers, ore carriers and combination carriers, *see* Pt 4, Ch 7,12.1.2 | Hatch covers in general | 2,0 |
| | Weather exposed plating and bottom plating of double skin hatch covers | 1,5 |
| | Internal structure of double skin hatch covers and closed box girders | 1,0 |
| | Hatch coamings | 1,5 |
| | Coaming stays and stiffeners | 1,5 |
| 'Tween deck hatches | Hatch covers in general | 1,0 |

## ■ *Section 2*
## Steel hatch covers

### 2.1 General

*2.1.1* The requirements of Section 2 are not applicable to hatch covers of bulk carriers, ore carriers and combination carriers.

*2.1.2* The strength requirements in 2.1 to 2.16 are applicable to hatch covers and closing arrangements of stiffened plate construction. The strength requirements are applicable to exposed weather deck hatch covers and 'tween deck hatch covers, unless otherwise stated.

*2.1.3* Sub-Sections 2.1 to 2.16 are not applicable to portable covers secured weathertight by tarpaulins and battening devices, or pontoon covers, *see* 2.17.

*2.1.4* Unless otherwise stated, the thicknesses referred to in the following Sections are net thicknesses. The net thicknesses are the member thicknesses necessary to obtain the minimum net scantlings required in this Section. The required gross thicknesses are obtained by adding corrosion additions, $t_c$, given in Table 11.1.2. Strength calculations using beam theory, grillage analysis or FEM are to be performed with net scantlings.

*2.1.5* Material class I is to be applied for hatch covers.

*2.1.6* The strength and closing arrangements of hatch covers are to comply with Pt 4, Ch 7,12 in addition to the requirements in this Chapter when hatch covers are subjected to internal ballast or oil cargo pressure.

*2.1.7* Hatch covers are to comply with Pt 4, Ch 8,11 in addition to the requirements in this Chapter when containers are carried on covers.

### 2.2 Stiffener arrangement

*2.2.1* The primary supporting members and secondary stiffeners of hatch covers are to be continuous over the breadth and length of hatch covers, as far as practical. When this is impractical, sniped end connections are not to be used and appropriate arrangements are to be adopted to ensure sufficient load-carrying capacity.

*2.2.2* The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed one third of the span of primary supporting members. When strength calculation is carried out by FE analysis using plane strain or shell elements, this requirement can be waived.

### 2.3 Load model

*2.3.1* The structural assessment of hatch covers is to be carried out using the design loads defined in this Section. The following symbols and definitions are applicable to this Section:

$x$ = longitudinal co-ordinate measured from the AP to mid point of assessed structural member

$T_{fb}$ = draught, in metres, corresponding to the assigned summer load line

$h_N$ = standard superstructure height in metres

= $1{,}05 + 0{,}01 L_L$, $1{,}8 \le h_N \le 2{,}3$

where

$L_L$ = load line length, as defined in Pt 3, Ch 1,6.1.8.

*2.3.2* The vertical weather design pressure, $p_H$, in kN/m$^2$, on the hatch cover panels is to be taken from Table 11.2.1. When cargo is carried on the cover, cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2 are to be considered. The vertical weather design load needs not to be combined with the cargo load. For 'tween deck hatch covers not exposed to weather load, the structural assessment is to be carried out using the cargo loads defined in 2.3.4 and 2.3.5. Covers carrying wheeled vehicles are also to comply with Ch 9,3 and where it is proposed to provide a helicopter landing area, covers are also to comply with Ch 9,5. Where an increased freeboard is assigned, the design load for hatch covers according to Table 11.2.1 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance at least equal to the standard superstructure height $h_N$ below the actual freeboard deck.

*2.3.3* The horizontal weather design pressure, in kN/m$^2$, for determining the scantlings of outer edge girders (skirt plates) of weather deck hatch covers is:

$$p_A = a\,c\,(b\,c_L\,f - z) \text{ kN/m}^2$$

$f = \dfrac{L}{25} + 4{,}1$ for $L < 90$ m

$= 10{,}75 - \left(\dfrac{300 - L}{100}\right)^{1{,}5}$ for 90 m $\le L <$ 300 m

$= 10{,}75$ for 300 m $\le L <$ 350 m

$= 10{,}75 - \left(\dfrac{L - 350}{150}\right)^{1{,}5}$ for 350 m $\le L \le$ 500 m

$c_L = \sqrt{\dfrac{L}{90}}$ for $L < 90$ m

$= 1$ for $L \ge$ 90 m

$a = 20 + \dfrac{L_1}{12}$ for unprotected front coamings and hatch cover skirt plates

$a = 10 + \dfrac{L_1}{12}$ for unprotected front coamings and hatch cover skirt plates where the distance from the actual freeboard deck to the summer load line exceeds the minimum non-corrected tabular freeboard according to ICLL by at least one standard superstructure height $h_N$

$a = 5 + \dfrac{L_1}{15}$ for side and protected front coamings and hatch cover skirt plates

$a = 7 + \dfrac{L_1}{100} - 8\,\dfrac{x'}{L}$ for aft ends of coamings and aft hatch cover skirt plates abaft amidships

$a = 5 + \dfrac{L_1}{100} - 4\,\dfrac{x'}{L}$ for aft ends of coamings and aft hatch cover skirt plates forward of amidships

$L_1$ = $L$, need not be taken greater than 300 m

$b = 1{,}0 + \left(\dfrac{\dfrac{x'}{L} - 0{,}45}{C_b + 0{,}2}\right)^2$ for $\left(\dfrac{x'}{L}\right) < 0{,}45$

$b = 1{,}0 + 1{,}5\left(\dfrac{\dfrac{x'}{L} - 0{,}45}{C_b + 0{,}2}\right)^2$ for $\left(\dfrac{x'}{L}\right) \ge 0{,}45$

$0{,}6 \le C_b \le 0{,}8$, when determining scantlings of aft ends of coamings and aft hatch cover skirt plates forward of amidships, $C_b$ need not be taken less than 0,8

$C_b$ = block coefficient, as defined in Pt 3, Ch 1,6.1.6

$x'$ = distance, in metres, between the transverse coaming or hatch cover skirt plate considered and aft end of the length $L$. When determining side coamings or side hatch cover skirt plates, the side is to be subdivided into parts of approximately equal length, not exceeding $0{,}15L$ each, and $x'$ is to be taken as the distance between aft end of the length $L$ and the centre of each part considered

$z$ = vertical distance in metres from the summer load line to the midpoint of stiffener span, or to the middle of the plate field

**Table 11.2.1 Design pressure $p_H$ of weather deck hatches**

| Position | $p_H$, in kN/m$^2$ | |
|---|---|---|
| 1 | $\frac{x}{L_L} \le 0{,}75$ | $0{,}75 < \frac{x}{L_L} \le 1{,}0$ |
| | For 24 m $\le L_L \le$ 100 m | |
| | $\frac{g}{76}\,(1{,}5L_L + 116)$ | on freeboard deck<br>$\frac{g}{76}\left[(4{,}28L_L + 28)\,\frac{x}{L_L} - 1{,}71L_L + 95\right]$ |
| | | upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck<br>$\frac{g}{76}\,(1{,}15L_L + 116)$ |
| | For $L_L > 100$ m | |
| | $3{,}5g$ | on freeboard deck for type B ships according to ICLL<br>$g\left[(0{,}0296L_1 + 3{,}04)\,\frac{x}{L_L} - 0{,}0222L_1 + 1{,}22\right]$ |
| | | on freeboard deck for ships with less freeboard than type B according to ICLL<br>$g\left[(0{,}1452L_1 - 8{,}52)\,\frac{x}{L_L} - 0{,}1089L_1 + 9{,}89\right]$<br>$L_1 = L_L$ but not more than 340 m |
| | | upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck<br>$3{,}5g$ |
| 2 | For 24 m $\le L_L \le$ 100 m | |
| | $\frac{g}{76}\,(1{,}1L_L + 87{,}6)$ | |
| | For $L_L > 100$ m | |
| | $2{,}6g$ | |
| | upon exposed superstructure decks located at least one superstructure standard height above the lowest Position 2 deck<br>$2{,}1g$ | |
| Symbols | | |
| $L_L$ = load line length, as defined in Pt 3, Ch 1,6.1.8<br>$g$ = acceleration due to gravity, 9,81 m/s$^2$ | | |

$c = 0{,}3 + 0{,}7\,\frac{b'}{B'}$

$b'$ = breadth of coaming in metres at the position considered

$B'$ = actual maximum breadth of ship in metres on the exposed weather deck at the position considered

$b'/B'$ is not to be taken less than 0,25

The design pressure $p_A$ is not to be taken less than the minimum values given in Table 11.2.2.

**Table 11.2.2 Minimum design load, $p_{Amin}$**

| $L$ | $P_{Amin}$, kN/m$^2$ | |
|---|---|---|
| | For unprotected fronts | Elsewhere |
| $\le 50$ | 30 | 15 |
| $> 50$ | $25 + \frac{L}{10}$ | $12{,}5 + \frac{L}{20}$ |
| $< 250$ | | |
| $\ge 250$ | 50 | 25 |

*2.3.4* The pressure on hatch covers due to distributed cargo loads $p_L$, in kN/m$^2$, resulting from heave and pitch, is to be determined according to the following formula:

$$p_L = p_c (1 + a_v) \text{ kN/m}^2$$

where

$p_c$ = uniform cargo load, in kN/m$^2$

NOTE

For 'tween deck hatch covers, $p_c$ is not to be taken less than 7,07 $H_{td}$ kN/m$^2$, *see* Ch 3,5.2.1, Table 3.5.1 and Fig 3.5.1. A design load less than this will be specially considered.

$a_v$ = acceleration addition as follows:

$a_v = F m$

$F = 0{,}11 \dfrac{v_0}{\sqrt{L}}$

$m = m_0 - 5(m_0 - 1)\dfrac{x}{L}$ for $0 \le \dfrac{x}{L} \le 0{,}2$

$= 1{,}0$ for $0{,}2 < \dfrac{x}{L} \le 0{,}7$

$= 1 + \dfrac{m_0 + 1}{0{,}3}\left(\dfrac{x}{L} - 0{,}7\right)$ for $0{,}7 < \dfrac{x}{L} \le 1{,}0$

$m_0 = 1{,}5 + F$

$v_0$ = max. speed at summer load line draught, $v_0$ is not to be taken less than $\sqrt{L}$, in knots.

*2.3.5* Point loads due to single forces, $P$, in kN, resulting from heave and pitch are to be determined as follows:

$P = P_s (1 + a_v)$ kN

$P_s$ = single force, in kN.

*2.3.6* In addition to the loads defined in this Section, hatch covers are loaded in the ship's transverse direction by forces due to elastic deformations of the ship's hull. Hatch covers are to be designed such that the sum of stresses does not exceed the permissible values given in 2.4.1.

### 2.4 Allowable stress and deflection

*2.4.1* The equivalent stress $\sigma_v$ in steel hatch cover structures related to the net thickness shall not exceed $0{,}8\sigma_o$, where $\sigma_o$ is the minimum yield stress, in N/mm$^2$, of the material. For design loads according to 2.3.3 to 2.3.6 and Pt 4, Ch 8,11.2, the equivalent stress $\sigma_v$ related to the net thickness shall not exceed $0{,}9\sigma_o$ when the stresses are assessed by means of FEM using plane stress or shell elements.

For beam element calculations and grillage analysis, the equivalent stress may be taken as follows:

$\sigma_v = \sqrt{\sigma^2 + 3\tau^2}$, in N/mm$^2$

$\sigma$ = normal stress in N/mm$^2$

$\tau$ = shear stress in N/mm$^2$

For FEM calculations, the equivalent stress may be taken as follows:

$\sigma_v = \sqrt{\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau^2}$, in N/mm$^2$

$\sigma_x$ = normal stress, in N/mm$^2$, in x-direction

$\sigma_y$ = normal stress, in N/mm$^2$, in y-direction

$\tau$ = shear stress, in N/mm$^2$, in the x-y plane

Indices x and y are coordinates of a two-dimensional Cartesian system in the plane of the considered structural element.

In the case of FEM calculations using shell or plane strain elements, the stresses are to be read from the centre of the individual element. Where shell elements are used, the stresses are to be evaluated at the mid plane of the element. Stress concentrations are to be considered. FEM calculations are to be carried out in accordance with the ShipRight procedure *Assessment of Steel Hatch Covers using Finite Element Analysis*.

*2.4.2* The vertical deflection of primary supporting members due to the vertical weather design load according to 2.3.2, or cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2, is to be not more than $0{,}0056 l_g$ where $l_g$ is the greatest span of primary supporting members.

For 'tween deck hatch covers not exposed to the vertical weather design load according to 2.3.2, the vertical deflection of primary supporting members due to the cargo loads according to 2.3.4, 2.3.5 and Pt 4, Ch 8,11.2 is to be not more than $0{,}007 l_g$ where $l_g$ is the greatest span of primary supporting members.

### 2.5 Local net plate thickness

*2.5.1* The local net plate thickness, $t$, in mm, of the hatch cover top plating is not to be less than:

$t = F_p\, 0{,}0158 s \sqrt{\dfrac{p}{0{,}95\sigma_o}}$

and to be not less than 1 per cent of the spacing of the stiffener or 6 mm, whichever is greater

$F_p$ = factor for combined membrane and bending response

= 1,5 in general

$= 1{,}9 \dfrac{\sigma}{\sigma_a}$, for $\dfrac{\sigma}{\sigma_a} \ge 0{,}8$

for the attached plate flange of primary supporting members

$s$ = stiffener spacing, in mm

$p$ = pressure $p_H$ and $p_L$, in kN/m$^2$, as defined in 2.3

$\sigma$ = normal stress, in N/mm$^2$, of hatch cover top plating

$\sigma_a = 0{,}8\sigma_o$, in N/mm$^2$

For flange plates under compression, sufficient buckling strength according to 2.11 is to be demonstrated.

The normal stress $\sigma$ of the hatch cover plating may be determined in a distance $s$ from webs of adjacent primary supporting members perpendicular to secondary stiffeners, and in a distance $s/2$ from the web of an adjacent primary supporting member parallel to secondary stiffeners, *see* Fig. 11.2.1. The greater of both stresses is to be taken. For the distribution of normal stress $\sigma$ between two parallel girders, *see* 2.14.1.

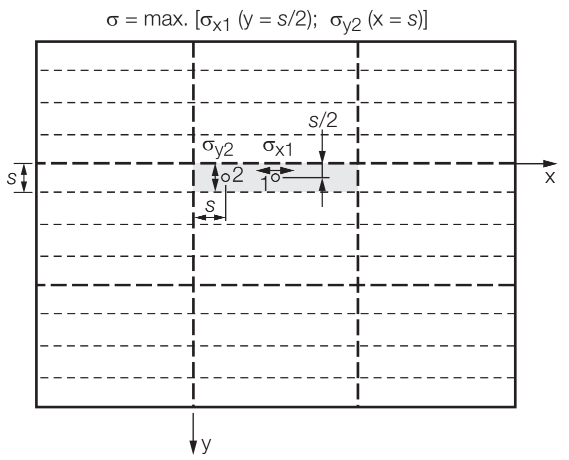


**Fig. 11.2.1**
**Determination of normal stress of the hatch cover plating**

### 2.6 Local plate thickness of hatch covers for wheel loading and helicopter landing

*2.6.1* The local gross plate thickness of hatch covers for wheel loading is to comply with Ch 9,3.

*2.6.2* The local gross plate thickness of hatch covers for helicopter landing is to comply with Ch 9,5.

### 2.7 Lower plating of double skin hatch covers and box girders

*2.7.1* The thickness to fulfil the strength requirements is to be obtained from the calculation according to 2.10 under consideration of permissible stresses according to 2.4.1. The net thickness must not be less than the larger of the following values when the lower plating is taken into account as a strength member of the hatch cover:

$t$ = $0,0065s$, in mm
$t_{min}$ = 5 mm
$s$ = stiffener spacing, in mm.

### 2.8 Net scantling of secondary stiffeners

*2.8.1* The net section modulus $Z$ and net shear area $A_s$ of uniformly loaded hatch cover stiffeners constrained at both ends is not to be less than:

$$Z = \frac{0,104}{\sigma_o} s\, l^2 p, \text{ in cm}^3$$

$$A_s = \frac{0,01}{\sigma_o} s\, l\, p \text{ , in cm}^2$$

where

$l$ = secondary stiffener span, in metres, to be taken as the spacing, in metres, of primary supporting members or the distance between a primary supporting member and the edge support, as applicable
$s$ = secondary stiffener spacing, in mm
$p$ = pressure $p_H$ and $p_L$, in kN/m$^2$, as defined in 2.3.

*2.8.2* The net section modulus of the secondary stiffeners is to be determined, based on an attached plate width assumed equal to the stiffener spacing.

*2.8.3* For flat bar secondary stiffeners and buckling stiffeners, the ratio $h/t_w$ is to be not greater than $15k^{0,5}$

where

$h$ = height of the stiffener
$t_w$ = net thickness of the stiffener
$k$ = $235/\sigma_o$.

*2.8.4* Stiffeners parallel to primary supporting members and arranged within the effective breadth according to 2.10 must be continuous when crossing primary supporting members and may be considered when calculating the cross-sectional properties of primary supporting members. It is to be verified that the combined stress of those stiffeners, induced by the bending of primary supporting members and lateral pressures, does not exceed the permissible stresses according to 2.4.1.

*2.8.5* For hatch cover stiffeners under compression, sufficient safety against lateral and torsional buckling according to 2.15 and 2.16 is to be verified.

*2.8.6* For hatch covers subject to wheel loading, stiffener gross scantlings are to comply with Ch 9,3.

*2.8.7* For hatch covers subject to helicopter landing, stiffener gross scantlings are to comply with Ch 9,5.

### 2.9 Net scantling of primary supporting members

*2.9.1* Scantlings of primary supporting members are obtained from calculations according to 2.10, under consideration of permissible stresses according to 2.4.1.

*2.9.2* For all components of primary supporting members, sufficient safety against buckling must be verified according to 2.11 to 2.16. For biaxial compressed flange plates, this is to be verified within the effective widths according to 2.14.1.

*2.9.3* The net thickness, $t$, in mm, of webs of primary supporting members is not to be less than:

(a) $0,0065s$, in mm
(b) 5 mm

where

$s$ = stiffener spacing, in mm.

*2.9.4* Scantlings of edge girders (skirt plates) are obtained from the calculations according to 2.10, under consideration of permissible stresses according to 2.4.1.

*2.9.5* The net thickness, $t$, in mm, of the outer edge girders exposed to wash of sea is not to be less than the largest of the following values:

(a) $0,0158s\sqrt{\dfrac{p_A}{0,95\sigma_o}}$

(b) 0,0085$s$ mm

(c) 5 mm

where

$p_A$ = horizontal pressure, as defined in 2.3.3
$s$ = stiffener spacing, in mm.

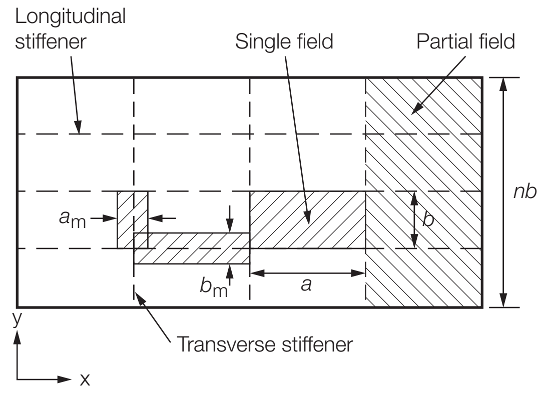
*2.9.6* The stiffness of edge girders is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, in cm$^4$, of edge girders is not to be less than:

$I$ = $6q\, s_{SD}^4$
$q$ = packing line pressure, in N/mm, minimum 5 N/mm
$s_{SD}$ = spacing, in metres, of securing devices.

### 2.10 Strength calculations

*2.10.1* Strength calculation for hatch covers may be carried out by using either beam theory, grillage analysis or FEM.

*2.10.2* The effective cross-sectional properties for calculation by beam theory or grillage analysis are to be determined considering the effective breadth. Cross-sectional areas of secondary stiffeners parallel to the primary supporting member under consideration within the effective breadth can be included, *see* Fig. 11.2.3. The effective breadth of plating, $e_m$, of primary supporting members is to be determined according to Table 11.2.3, considering the type of loading. Special calculations may be required for determining the effective breadth of one-sided or non-symmetrical flanges. The effective cross-sectional area of plates is not to be less than the cross-sectional area of the face-plate. For flange plates under compression with secondary stiffeners perpendicular to the web of the primary supporting member, the effective width is to be determined according to 2.14.1.



Longitudinal : stiffener in the direction of the length *a*
Transverse : stiffener in the direction of the length *b*

**Fig. 11.2.2**
**General arrangement of panel**

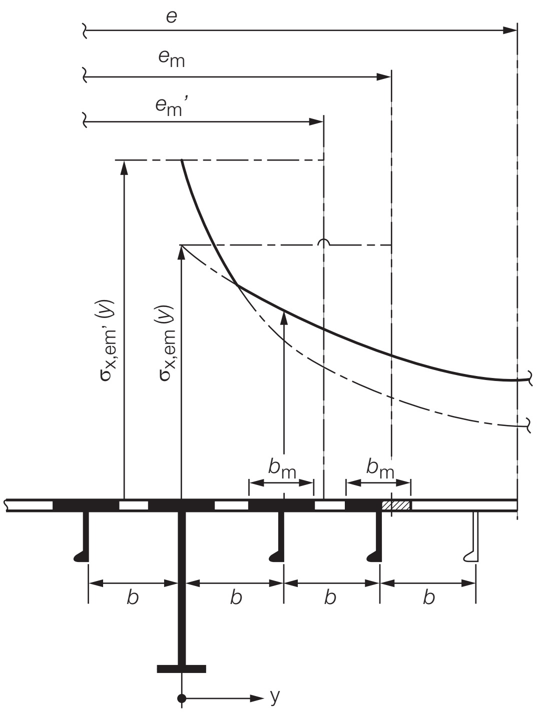


**Fig. 11.2.3**
**Stiffening parallel to web of primary supporting member**

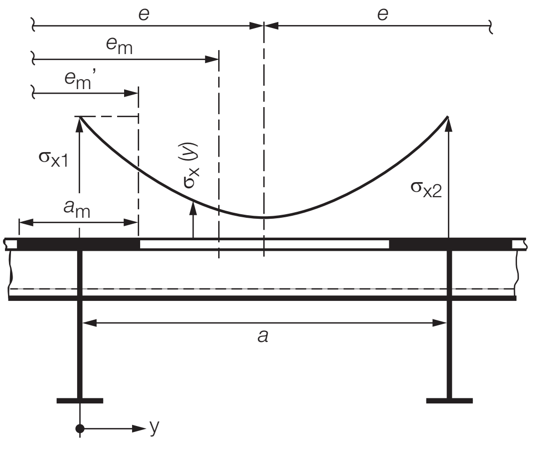


**Fig. 11.2.4**
**Stiffening perpendicular to web of primary supporting member**

**Table 11.2.3 Effective breadth $e_m$ of plating of primary supporting members**

| $l/e$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | ≥8 |
|---|---|---|---|---|---|---|---|---|---|
| $e_{m1}/e$ | 0 | 0,36 | 0,64 | 0,82 | 0,91 | 0,96 | 0,98 | 1,00 | 1,00 |
| $e_{m2}/e$ | 0 | 0,20 | 0,37 | 0,52 | 0,65 | 0,75 | 0,84 | 0,89 | 0,90 |

Symbols

$e_{m1}$ is to be applied where primary supporting members are loaded by uniformly distributed loads or else by no fewer than six equally spaced single loads

$e_{m2}$ is to be applied where primary supporting members are loaded by 3 or fewer single loads. Intermediate values may be obtained by direct interpolation

$l$ length of zero-points of bending moment curve:
$l = l_0$ for simply supported primary supporting members
$l = 0{,}6 l_0$ for primary supporting members with both ends constrained

where

$l_0$ is the unsupported length of the primary supporting member

$e$ width of plating supported, measured from centre to centre of the adjacent unsupported fields

### 2.11 Buckling strength of hatch cover structures

*2.11.1* For hatch cover structures, sufficient buckling strength is to be demonstrated.

$a$ = length of the longer side of a single plate field, in mm
$b$ = breadth of the shorter side of a single plate field, in mm
$\alpha$ = aspect ratio of single plate field
= $a/b$
$n$ = number of single plate field breadths within the partial or total plate field
$t$ = net plate thickness, in mm
$\sigma_x$ = membrane stress, in N/mm$^2$, in x-direction
$\sigma_y$ = membrane stress, in N/mm$^2$, in y-direction
$\tau$ = shear stress, in N/mm$^2$, in the x-y plane
$E$ = modulus of elasticity, in N/mm$^2$, of the material
= $2{,}06 \times 10^5$ N/mm$^2$ for steel
$\sigma_F$ = minimum yield stress, in N/mm$^2$, of the material.

Compressive and shear stresses are to be taken positive, tension stresses are to be taken negative.

If stresses in the x- and y-direction already contain the Poisson effect (calculated using FEM), the following modified stress values may be used. Both stresses $\sigma_x^*$ and $\sigma_y^*$ are to be compressive stresses, in order to apply the stress reduction according to the following formulae.

$$\sigma_x = \frac{(\sigma_x^* - 0{,}3\sigma_y^*)}{0{,}91}$$

$$\sigma_y = \frac{(\sigma_y^* - 0{,}3\sigma_x^*)}{0{,}91}$$

$\sigma_x^*, \sigma_y^*$ = stresses containing the Poisson effect where compressive stress fulfils the condition
$\sigma_y^* < 0{,}3\sigma_x^*$, then $\sigma_y = 0$ and $\sigma_x = \sigma_x^*$
where compressive stress fulfils the condition
$\sigma_x^* < 0{,}3\sigma_y^*$, then $\sigma_x = 0$ and $\sigma_y = \sigma_y^*$
$F_1$ = correction factor for boundary condition at the longitudinal stiffeners according to Table 11.2.4
$\sigma_e$ = reference stress, in N/mm$^2$, taken equal to

$$= 0{,}9E\left(\frac{t}{b}\right)^2$$

$\psi$ = edge stress ratio taken equal to

$$= \frac{\sigma_2}{\sigma_1}$$

where

$\sigma_1$ = maximum compressive stress
$\sigma_2$ = minimum compressive stress or tension stress
$S$ = safety factor (based on net scantling approach), taken equal to
= 1,25 for hatch covers when subjected to the vertical weather design load according to 2.3.2
= 1,10 for hatch covers when subjected to loads according to 2.3.3 to 2.3.6 and Pt 4, Ch 8,11,2
$\lambda$ = reference degree of slenderness, taken equal to:

$$= \sqrt{\frac{\sigma_o}{K\sigma_e}}$$

$K$ = buckling factor according to Table 11.2.6.

**Table 11.2.4 Correction factor $F_1$**

| | | |
|---|---|---|
| Stiffeners sniped at both ends | 1,00 | |
| Guidance values, *see* Note 1, where both ends are effectively connected to adjacent structures | 1,05<br>1,10<br>1,21<br>1,30 | for flat bars<br>for bulb sections<br>for angle and tee-sections<br>for u-type sections, *see* Note 2, and girders of high rigidity |
| An average value of *F*, *see* Note 1, is to be used for plate panels having different edge stiffeners | | |

NOTES
1. Exact values may be determined by direct calculations.
2. A higher value, but not greater than 2,0, may be taken if it is verified by a buckling strength check of the partial plate field using non-linear FEA. The calculations are to be submitted to LR for approval.

*2.11.2* Proof is to be provided that the following condition is complied with for the single plate field *a b*:

$$\left(\frac{|\sigma_x|\,S}{\kappa_x\,\sigma_o}\right)^{e1} + \left(\frac{|\sigma_y|\,S}{\kappa_y\,\sigma_o}\right)^{e2} - B\left(\frac{\sigma_x\,\sigma_y\,S^2}{\sigma_o^{\,2}}\right) + \left(\frac{|\tau|S\sqrt{3}}{\kappa_\tau\,\sigma_o}\right)^{e3} \leq 1{,}0$$

The first two terms and the last term of the above condition shall not exceed 1,0.
The reduction factors $\kappa_x$, $\kappa_y$ and $\kappa_\tau$ are given in Table 11.2.6.
Where $\sigma_x \leq 0$ (tension stress), $\kappa_x = 1{,}0$.
Where $\sigma_y \leq 0$ (tension stress), $\kappa_y = 1{,}0$.
The exponents $e_1$, $e_2$ and $e_3$ as well as the factor *B* are to be taken as given by Table 11.2.5.

**Table 11.2.5 Coefficients $e_1$, $e_2$, $e_3$ and factor *B***

| Exponents $e_1$ to $e_3$ and factor B | Plate panel |
|---|---|
| $e_1$ | $1 + \kappa_x^{\,4}$ |
| $e_2$ | $1 + \kappa_y^{\,4}$ |
| $e_3$ | $1 + \kappa_x\,\kappa_y\,\kappa_\tau^{\,2}$ |
| *B*<br>$\sigma_x$ and $\sigma_y$ positive<br>(compression stress) | $(\kappa_x\,\kappa_y)^5$ |
| *B*<br>$\sigma_x$ or $\sigma_y$ negative<br>(tension stress) | 1 |

### 2.12 Webs and flanges of primary supporting members

*2.12.1* For non-stiffened webs and flanges of primary supporting members, sufficient buckling strength, as for the hatch cover top and lower plating, is to be demonstrated according to 2.11.2.

### 2.13 Longitudinal and transverse secondary stiffeners

*2.13.1* It is to be demonstrated that the continuous longitudinal and transverse stiffeners of partial and total plate fields comply with the conditions set out in 2.15 and 2.16.

### 2.14 Effective width of top and lower hatch cover plating

*2.14.1* For demonstration of buckling strength according to 2.15 and 2.16, the effective width of plating may be determined by the following formulae:

$b_m = \kappa_x\,b$ for longitudinal stiffeners
$a_m = \kappa_y\,a$ for transverse stiffeners

*see also* Fig. 11.2.2.
The effective width of plating is not to be taken greater than the value obtained from 2.10.2.
The effective width $e'_m$ of stiffened flange plates of primary supporting members may be determined as follows:

(a) Stiffening parallel to web of primary supporting member:

$b < e_m$
$e'_m = n\,b_m$
$n$ = integer number of stiffener spacings *b* inside the effective breadth $e_m$ according to 2.10.2
$= \text{int}\left(\frac{e_m}{b}\right)$

(b) Stiffening perpendicular to web of primary supporting member:

$a \geq e_m$
$e'_m = n\,a_m < e_m$
$n = 2{,}7\,\frac{e_m}{a} \leq l$
$e$ = width of plating supported according to 2.10.2

For $b \geq e_m$ or $a < e_m$, respectively, *b* and *a* are to be exchanged.
$a_m$ and $b_m$ for flange plates are in general to be determined for $\psi = 1$.
Scantlings of plates and stiffeners are in general to be determined according to the maximum stresses $\sigma_x$ (*y*) at webs of primary supporting member and stiffeners, respectively. For stiffeners with spacing *b* under compression arranged parallel to primary supporting members, no value less than $0{,}25\sigma_o$ shall be inserted for $\sigma_x$ (*y=b*).
The stress distribution between two primary supporting members can be obtained by the following formula:

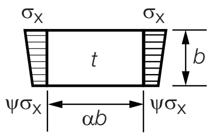
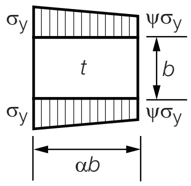
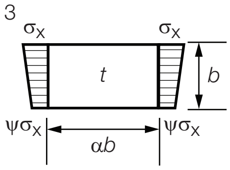
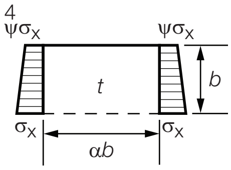
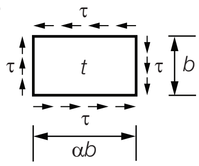
$$\sigma_x(y) = \sigma_{x1}\left\{1 - \frac{y}{e}\left[3 + c_1 - 4c_2 - 2\,\frac{y}{e}(1 + c_1 - 2c_2)\right]\right\}$$

where

$c_1 = \frac{\sigma_{x2}}{\sigma_{x1}} \quad 0 \leq c_1 \leq 1$
$c_2 = \frac{1{,}5}{e}\,(e_{m1}" + e_{m2}") - 0{,}5$
$e_{m1}"$ = proportionate effective breadth $e_{m1}$ or proportionate effective width $e_{m1}'$ of primary supporting member 1 within the distance *e*, as appropriate
$e_{m2}"$ = proportionate effective breadth $e_{m2}$ or proportionate effective width $e_{m2}'$ of primary supporting member 2 within the distance *e*, as appropriate
$\sigma_{x1}, \sigma_{x2}$ = normal stresses in flange plates of adjacent primary supporting member 1 and 2 with spacing *e*, based on cross-sectional properties considering the effective breadth or effective width, as appropriate
$y$ = distance of considered location from primary supporting member 1

Shear stress distribution in the flange plates may be assumed linearly.

**Table 11.2.6 Buckling and reduction factors for plane elementary plate panels**

| Buckling load case | Edge stress ratio $\psi$ | Asp. ratio $\alpha = \frac{a}{b}$ | Buckling factor $K$ | Reduction factor $\kappa$ |
|---|---|---|---|---|
| 1   $\sigma_x$<br>$\sigma_x$<br>$t$<br>$b$<br>$\psi\sigma_x$<br>$\alpha b$<br>$\psi\sigma_x$ | $1 \geq \psi \geq 0$ | $\alpha \geq 1$ | $K = \dfrac{8,4}{\psi + 1,1}$ | $K_x = 1$ for $\lambda \leq \lambda_c$<br>$K_x = c\left(\dfrac{1}{\lambda} - \dfrac{0,22}{\lambda^2}\right)$ for $\lambda > \lambda_c$<br>$c = (1,25 - 0,12\psi) \leq 1,25$<br>$\lambda_c = \dfrac{c}{2}\left(1 + \sqrt{1 - \dfrac{0,88}{c}}\right)$ |
| | $0 > \psi > -1$ | | $K = 7,63 - \psi\,(6,26 - 10\psi)$ | |
| | $\psi \leq -1$ | | $K = 5,975\,(1 - \psi)^2$ | |
| 2   $\sigma_y$<br>$\psi\sigma_y$<br>$t$<br>$b$<br>$\sigma_y$<br>$\psi\sigma_y$<br>$\alpha b$ | $1 \geq \psi \geq 0$ | $\alpha \geq 1$ | $K = F_1\left(1 + \dfrac{1}{\alpha^2}\right)^2 \dfrac{2,1}{(\psi + 1,1)}$ | $K_y = c\left(\dfrac{1}{\lambda} - \dfrac{R + F^2\,(H - R)}{\lambda^2}\right)$<br>$c = (1,25 - 0,12\psi) \leq 1,25$<br>$R = \lambda\left(1 - \dfrac{\lambda}{c}\right)$ for $\lambda < \lambda_c$<br>$R = 0,22$ for $\lambda \geq \lambda_c$<br>$\lambda_c = \dfrac{c}{2}\left(1 + \sqrt{1 - \dfrac{0,88}{c}}\right)$<br>$F = \left(1 - \dfrac{\dfrac{K}{0,91} - 1}{\lambda_p^2}\right) c_1 \geq 0$<br>$\lambda_p^2 = \lambda^2 - 0,5$ for $1 \leq \lambda_p^2 \leq 3$<br>$c_1 = \left(1 - \dfrac{F_1}{\alpha}\right) \geq 0$<br>$H = \lambda - \dfrac{2\lambda}{c\,(T + \sqrt{T^2 - 4})} \geq R$<br>$T = \lambda + \dfrac{14}{15\lambda} + \dfrac{1}{3}$ |
| | $0 > \psi > -1$ | $1 \leq \alpha \leq 1,5$ | $K = F_1\left[\left(1 + \dfrac{1}{\alpha^2}\right)^2 \dfrac{2,1\,(1 + \psi)}{1,1} - \dfrac{\psi}{\alpha^2}\,(13,9 - 10\psi)\right]$ | |
| | | $\alpha > 1,5$ | $K = F_1\left[\left(1 + \dfrac{1}{\alpha^2}\right)^2 \dfrac{2,1\,(1 + \psi)}{1,1} - \dfrac{\psi}{\alpha^2}\,(5,87 + 1,87\alpha^2 + \dfrac{8,6}{\alpha^2} - 10\psi)\right]$ | |
| | $\psi \leq -1$ | $1 \leq \alpha \leq \dfrac{3\,(1 - \psi)}{4}$ | $K = 5,975 F_1\left(\dfrac{1 - \psi}{\alpha}\right)^2$ | |
| | | $\alpha > \dfrac{3\,(1 - \psi)}{4}$ | $K = F_1\left[3,9675\left(\dfrac{1 - \psi}{\alpha}\right)^2 + 0,5375\left(\dfrac{1 - \psi}{\alpha}\right)^4 + 1,87\right]$ | |
| 3   $\sigma_x$<br>$\sigma_x$<br>$t$<br>$b$<br>$\psi\sigma_x$<br>$\alpha b$<br>$\psi\sigma_x$ | $1 \geq \psi \geq 0$ | $\alpha > 0$ | $K = \dfrac{4\left(0,425 + \dfrac{1}{\alpha^2}\right)}{3\psi + 1}$ | $\kappa_x = 1$ for $\lambda \leq 0,7$<br>$\kappa_x = \dfrac{1}{\lambda^2 + 0,51}$ for $\lambda > 0,7$ |
| | $0 > \psi \geq -1$ | | $K = 4\left(0,425 + \dfrac{1}{\alpha^2}\right)(1 + \psi) - 5\psi\,(1 - 3,42\psi)$ | |
| 4   $\psi\sigma_x$<br>$\psi\sigma_x$<br>$t$<br>$b$<br>$\sigma_x$<br>$\alpha b$<br>$\sigma_x$ | $1 \geq \psi \geq -1$ | $\alpha > 0$ | $K = \left(0,425 + \dfrac{1}{\alpha^2}\right)\dfrac{3 - \psi}{2}$ | |
| 5   $\tau$<br>$\tau$<br>$t$<br>$\tau$<br>$b$<br>$\tau$<br>$\alpha b$ | — | | $K = K_\tau \sqrt{3}$ | $\kappa_\tau = 1$ for $\lambda \leq 0,84$<br>$\kappa_\tau = \dfrac{0,84}{\lambda}$ for $\lambda > 0,84$ |
| | | $\alpha \geq 1$ | $K_\tau = \left(5,34 + \dfrac{4}{\alpha^2}\right)$ | |
| | | $0 < \alpha < 1$ | $K_\tau = \left(4 + \dfrac{5,34}{\alpha^2}\right)$ | |
| Explanations for boundary conditions | -------- plate edge free<br>———— plate edge simply supported | | | |

### 2.15 Lateral buckling of secondary stiffeners

*2.15.1* The secondary stiffeners are to comply with the following criteria:

$$\frac{\sigma_a + \sigma_b}{\sigma_o} S \leq 1$$

where

$\sigma_a$ = uniformly distributed compressive stress, in N/mm$^2$, in the direction of the stiffener axis

$\sigma_a$ = $\sigma_x$ for longitudinal stiffeners

$\sigma_a$ = $\sigma_y$ for transverse stiffeners

$\sigma_b$ = bending stress, in N/mm$^2$, in the stiffener

$= \dfrac{M_0 + M_1}{Z_{st} \times 10^3}$

$M_0$ = bending moment, in Nmm, due to the deformation $w$ of stiffener, taken equal to:

$M_0 = F_{Ki} \dfrac{p_z w}{c_f - p_z}$ with $(c_f - p_z) > 0$

$M_1$ = bending moment, in Nmm, due to the lateral load $p$ equal to:

$M_1 = \dfrac{p\, b\, a^2}{24 \times 10^3}$ for longitudinal stiffeners

$M_1 = \dfrac{p\, a\, (n\, b)^2}{8 c_s \times 10^3}$ for transverse stiffeners

$n$ is to be taken equal to 1 for ordinary transverse stiffeners

$p$ = lateral load, in kN/m$^2$

$F_{Ki}$ = ideal buckling force, in N, of the stiffener

$F_{Kix} = \dfrac{\pi^2}{a^2} E I_x \times 10^4$ for longitudinal stiffeners

$F_{Kiy} = \dfrac{\pi^2}{(n\, b)^2} E I_y \times 10^4$ for transverse stiffeners

$I_x, I_y$ = net moments of inertia, in cm$^4$, of the longitudinal or transverse stiffener, including effective width of attached plating according to 2.14.1. $I_x$ and $I_y$ are to comply with the following criteria:

$I_x \geq \dfrac{b\, t^3}{12 \times 10^4}$

$I_y \geq \dfrac{a\, t^3}{12 \times 10^4}$

$p_z$ = nominal lateral load, in N/mm$^2$, of the stiffener due to $\sigma_x$, $\sigma_y$ and $\tau$

$p_{zx} = \dfrac{t}{b} \left( \sigma_{xl} \left( \dfrac{\pi\, b}{a} \right)^2 + 2 c_y \sigma_y + \sqrt{2}\, \tau_1 \right)$

for longitudinal stiffeners

$p_{zy} = \dfrac{t}{a} \left( 2 c_x \sigma_{xl} + \sigma_y \left( \dfrac{\pi\, a}{n\, b} \right)^2 \left( 1 + \dfrac{A_y}{a\, t} \right) + \sqrt{2}\, \tau_1 \right)$

for transverse stiffeners

$\sigma_{xl} = \sigma_x \left( 1 + \dfrac{A_x}{b\, t} \right)$

$c_x, c_y$ = factor taking into account the stresses perpendicular to the stiffener's axis and distributed variably along the stiffener's length

$= 0{,}5\,(1 + \psi)$ for $0 \leq \psi \leq 1$

$= \dfrac{0{,}5}{1 - \psi}$ for $\psi < 0$

$A_x, A_y$ = net sectional area, in mm$^2$, of the longitudinal or transverse stiffener, respectively, without attached plating

$\tau_1 = \left[ \tau - t \sqrt{\sigma_o E \left( \dfrac{m_1}{a^2} + \dfrac{m_2}{b^2} \right)} \right] \geq 0$

for longitudinal stiffeners:

$\dfrac{a}{b} \geq 2{,}0$ : $m_1 = 1{,}47$ $m_2 = 0{,}49$

$\dfrac{a}{b} < 2{,}0$ : $m_1 = 1{,}96$ $m_2 = 0{,}37$

for transverse stiffeners:

$\dfrac{a}{n\, b} \geq 0{,}5$ : $m_1 = 0{,}37$ $m_2 = \dfrac{1{,}96}{n^2}$

$\dfrac{a}{n\, b} < 0{,}5$ : $m_1 = 0{,}49$ $m_2 = \dfrac{1{,}47}{n^2}$

$w = w_0 + w_1$

$w_0$ = assumed imperfection, in mm

$w_{0x} = \leq \min\left( \dfrac{a}{250}, \dfrac{b}{250}, 10 \right)$ for longitudinal stiffeners

$w_{0y} = \leq \min\left( \dfrac{a}{250}, \dfrac{n\, b}{250}, 10 \right)$ for transverse stiffeners

NOTE

For stiffeners sniped at both ends, $w_o$ must not be taken less than the distance from the midpoint of plating to the neutral axis of the profile, including effective width of plating

$w_1$ = deformation of stiffener, in mm, at midpoint of stiffener span due to lateral load $p$

In the case of uniformly distributed load, the following values for $w_1$ may be used:

$w_1 = \dfrac{p\, b\, a^4}{384 \times 10^7 E I_x}$ for longitudinal stiffeners

$w_1 = \dfrac{5 a\, p\, (n\, b)^4}{384 \times 10^7 E I_y c_s^2}$ for transverse stiffeners

$c_f$ = elastic support provided by the stiffener, in N/mm$^2$

(i) For longitudinal stiffeners:

$c_{fx} = F_{Kix} \dfrac{\pi^2}{a^2} (1 + c_{px})$

$$c_{px} = \frac{1}{1 + \dfrac{0{,}91 \left( \dfrac{12 \times 10^4 I_x}{t^3 b} - 1 \right)}{c_{xa}}}$$

$c_{xa} = \left( \dfrac{a}{2b} + \dfrac{2b}{a} \right)^2$ for $a \geq 2b$

$c_{xa} = \left( 1 + \left( \dfrac{a}{2b} \right)^2 \right)^2$ for $a < 2b$

(ii) For transverse stiffeners:

$c_{fy} = c_S F_{Kiy} \dfrac{\pi^2}{(n\, b)^2} (1 + c_{py})$

$$c_{py} = \frac{1}{1 + \dfrac{0{,}91\left(\dfrac{12 \times 10^4 I_y}{t^3 a} - 1\right)}{c_{ya}}}$$

$$c_{ya} = \left(\frac{n\,b}{2a} + \frac{2a}{n\,b}\right)^2 \quad \text{for } n\,b \geq 2a$$

$$c_{ya} = \left(1 + \left(\frac{n\,b}{2a}\right)^2\right)^2 \quad \text{for } n\,b < 2a$$

$c_s$ = factor accounting for the boundary conditions of the transverse stiffener
= 1,0 for simply supported stiffeners
= 2,0 for partially constrained stiffeners

$Z_{st}$ = net section modulus of stiffener (longitudinal or transverse), in cm$^3$, including effective width of plating according to 2.14.1.

If no lateral load $p$ is acting, the bending stress $\sigma_b$ is to be calculated at the midpoint of the stiffener span for that fibre which results in the largest stress value. If a lateral load $p$ is acting, the stress calculation is to be carried out for both fibres of the stiffener's cross-sectional area (if necessary for the biaxial stress field at the plating side).

### 2.16 Torsional buckling of secondary stiffeners

*2.16.1* The longitudinal secondary stiffeners are to comply with the following criteria:

$$\frac{\sigma_x S}{\kappa_T \sigma_o} \leq 1{,}0$$

where

$\kappa_T$ = coefficient taken equal to:

$\kappa_T$ = 1,0 for $\lambda_T \leq 0{,}2$

$$\kappa_T = \frac{1}{\phi + \sqrt{\phi^2 - \lambda_T^2}} \quad \text{for } \lambda_T > 0{,}2$$

$\phi$ = 0,5 $(1 + 0{,}21\,(\lambda_T - 0{,}2) + \lambda_T^2)$

$\lambda_T$ = reference degree of slenderness taken equal to:

$$\lambda_T = \sqrt{\frac{\sigma_F}{\sigma_{KiT}}}$$

$$\sigma_{KiT} = \frac{E}{I_p}\left(\frac{\pi^2 I_\omega 10^2}{a^2}\,\varepsilon + 0{,}385 I_T\right), \text{ in N/mm}^2$$

For $I_P$, $I_T$, $I_\omega$, *see* Fig. 11.2.5 and Table 11.2.7

$I_P$ = net polar moment of inertia of the stiffener, in cm$^4$, related to the point $C$

$I_T$ = net St.Venant's moment of inertia of the stiffener, in cm$^4$

$I_\omega$ = net sectorial moment of inertia of the stiffener, in cm$^6$, related to the point $C$

$\varepsilon$ = degree of fixation taken equal to:

$$\varepsilon = 1 + 10^{-3}\sqrt{\frac{a^4}{\dfrac{3}{4}\pi^4 I_\omega\left(\dfrac{b}{t^3} + \dfrac{4h_w}{3t_w^3}\right)}}$$

$h_w$ = web height, in mm

$t_w$ = net web thickness, in mm

$b_f$ = flange breadth, in mm

$t_f$ = net flange thickness, in mm

$A_w$ = net web area equal to: $A_w = h_w\,t_w$

$A_f$ = net flange area equal to: $A_f = b_f\,t_f$

$e_f = h_w + \dfrac{t_f}{2}$, in mm

$b$ = stiffener spacing, in mm

$t$ = local net plate thickness of the attached plate, in mm.

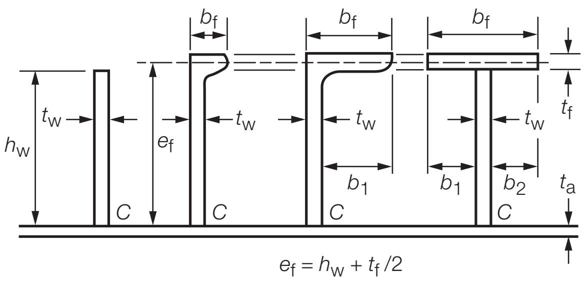


**Fig. 11.2.5 Dimensions of stiffener**

**Table 11.2.7 Moments of inertia**

| Section | $I_P$ | $I_T$ | $I_\omega$ |
|---|---|---|---|
| Flat bar | $\dfrac{h_w^3\,t_w}{3 \times 10^4}$ | $\dfrac{h_w\,t_w^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_w}{h_w}\right)$ | $\dfrac{h_w^3\,t_w^3}{36 \times 10^6}$ |
| Sections with bulb or flange | $\left(\dfrac{A_w\,h_w^2}{3} + A_f\,e_f^2\right)10^{-4}$ | $\dfrac{h_w\,t_w^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_w}{h_w}\right) +$<br>$\dfrac{b_f\,t_f^3}{3 \times 10^4}\left(1 - 0{,}63\,\dfrac{t_f}{b_f}\right)$ | for bulb and angle sections:<br>$\dfrac{A_f\,e_f^2\,b_f^2}{12 \times 10^6}\left(\dfrac{A_f + 2{,}6A_W}{A_f + A_W}\right)$<br>for tee sections:<br>$\dfrac{b_f^3\,t_f\,e_f^2}{12 \times 10^6}$ |

*2.16.2* For transverse secondary stiffeners loaded by compressive stresses and which are not supported by longitudinal stiffeners, sufficient torsional buckling strength is to be demonstrated analogously in accordance with this sub-Section.

### 2.17 Pontoon covers

*2.17.1* The structural assessment of pontoon covers, as defined in 1.1.5(b), is to be carried out by direct calculations, which are to be submitted for approval, using the minimum design pressures acting on the hatch covers defined in Table 11.2.8. The permissible stress, deflection and buckling criteria are given in Table 11.2.10.

*2.17.2* The gross thickness of the plating of steel pontoon covers is to be not less than the greater of:

(a) $t$ = 0,01$s$ mm

(b) $t$ = 6,0 mm as required by Table 11.2.8

where

$s$ = stiffener spacing in mm

$t$ = thickness as required by 2.17.1.

*2.17.3* The gross scantlings of steel pontoon cover primary and secondary webs or stiffeners are to be not less than would be required to satisfy the requirements of Table 11.2.11. Alternatively, scantlings may be determined by direct calculations, which are to be submitted for approval. In no case are the stresses and deflections given in Table 11.2.10 to be exceeded.

**Table 11.2.8 Pontoon cover minimum design pressures**

| |
|---|
| For ships of 100 m in length and above: |
| (a) Position 1 hatch covers located in the forward quarter of the ship's length shall be designed for wave pressures at the forward perpendicular, calculated from the following equation:<br>Minimum design pressure, $p$ = 49,05 + 9,81 ($L_H$ –100) $a$ in kN/m$^2$<br>where<br>$L_H$ is $L$ for ships of not more than 340 m but not less than 100 m in length and equal to 340 m for ships of more than 340 m in length:<br>$a$ = 0,0074 for Type B freeboard ships<br>= 0,0363 ships assigned reduced freeboard<br>The pressure, $p$, is to be reduced linearly to 34,3 kN/m$^2$ at the end of the forward quarter's length, as shown in Table 11.2.9<br>The design pressure used for each hatch cover panel shall be that determined at its midpoint location:<br>(b) All other position 1 hatch covers shall be designed to 34,3 kN/m$^2$<br>(c) Position 2 hatch covers shall be designed to 25,5 kN/m$^2$<br>(d) Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, it may be designed to 34,3 kN/m$^2$ |
| For ships 24 m in length: |
| (a) Position 1 hatch covers located in the forward quarter of the ship's length shall be designed for wave pressures of 23,8 kN/m$^2$ at the forward perpendicular and reduced linearly to 19,6 kN/m$^2$ at the end of the forward quarter's length, as shown in Table 11.2.9<br>The design pressure used for each hatch cover panel shall be that determined at its midpoint location<br>(b) All other position 1 hatch covers shall be designed to 19,6 kN/m$^2$<br>(c) Position 2 hatch covers shall be designed to 14,7 kN/m$^2$<br>(d) Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, it may be designed to 19,6 $t$/m$^2$ |
| For ships between 24 m and 100 m in length, and for positions between FP and 0,25$L$, wave pressures shall be obtained by linear interpolation of the values shown in Table 11.2.9 |

**Table 11.2.9 Summary of pontoon cover minimum design pressures**

| Deck location | Longitudinal position | | |
|---|---|---|---|
| | FP | 0,25$L$ | Aft of 0,25$L$ |
| $L$>100 m | | | |
| Freeboard deck | Equation given in Table 11.2.8(a) | 34,3 kN/m$^2$ | 34,3 kN/m$^2$ |
| Superstructure deck | 34,3 kN/m$^2$ | | 25,5 kN/m$^2$ |
| $L$ = 100 m | | | |
| Freeboard deck | 49,05 kN/m$^2$ | 34,3 kN/m$^2$ | 34,3 kN/m$^2$ |
| Superstructure deck | 34,3 kN/m$^2$ | | 25,5 kN/m$^2$ |
| $L$ = 24 m | | | |
| Freeboard deck | 23,84 kN/m$^2$ | 19,6 kN/m$^2$ | 19,6 kN/m$^2$ |
| Superstructure deck | 19,6 kN/m$^2$ | | 14,7 kN/m$^2$ |

**Table 11.2.10 Steel pontoon cover permissible stress, deflection and buckling criteria**

| Location | Permissible bending stress, N/mm$^2$ | Permissible shear stress, N/mm$^2$ | Permissible deflection, metres |
|---|---|---|---|
| Weather deck – Positions 1 and 2 | $0{,}68\sigma_o$ | $0{,}39\sigma_o$ | $0{,}0044 l_0$ |
| Buckling requirements | | | |
| Symbols | | | |

$b$ = length of panel (longer panel dimension), in mm, in transverse direction, *see* Fig. 11.2.6

$s$ = spacing of webs and stiffeners (shorter panel dimension), in mm

$t$ = thickness of plating, in mm

$\sigma_{ac}$ = corrected critical buckling stress, in N/mm$^2$

$\sigma_b$ = the compressive bending stress, in N/mm$^2$, in the steel cover plating, calculated by taking the cover as a loaded beam simply supported at its ends

$\sigma_c$ = critical buckling stress of panel, in N/mm$^2$

$\sigma_o$ = yield stress of cover plating material, in N/mm$^2$

$$\sigma_c = 18{,}6 R_c \left(\frac{t}{b}\right)^2 \times 10^4 \quad \text{N/mm}^2$$

$$\sigma_{ac} = \sigma_o \left(1 - \frac{\sigma_o}{4\sigma_c}\right) \quad \text{N/mm}^2$$

(a) Where primary bending stress acts on longer panel edge $b$, *see* Fig. 11.2.6:

$$\frac{\sigma_c}{\sigma_b} \left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \geq 1{,}3 \qquad \text{where } R_c = \left(\frac{s}{b} + \frac{b}{s}\right)^2$$

Where primary bending stress acts on shorter panel edge $s$:

$$\frac{\sigma_c}{\sigma_b} \left(\text{or } \frac{\sigma_{ac}}{\sigma_b}\right) \geq 1{,}2 \qquad \text{where } R_c = 4 \left(\frac{b^2}{s^2}\right)$$

If $\sigma_c > 0{,}5\ \sigma_o$, then corrected value $\sigma_{ac}$ is used

It is recommended that $\dfrac{b}{s} < 5{,}0$

(b) Where covers are stiffened in two directions by a grillage formation, buckling checks are to be carried out as per (a) above for bending stresses acting on both the longer and shorter edges of the panel.
For the derivation of the section modulus for primary members, an effective width of plating to achieve a balanced section is to be adopted.
However, a greater width of plating in accordance with Ch 3,3.2 may be adopted where this is suitably stiffened in the directions being considered from the buckling aspect.

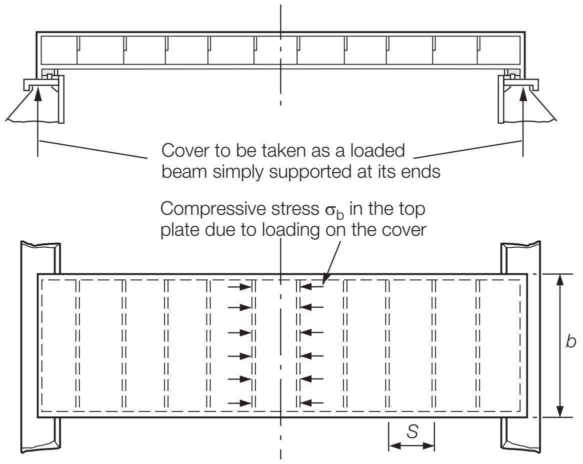

Cover to be taken as a loaded beam simply supported at its ends
Compressive stress $\sigma_b$ in the top plate due to loading on the cover
b
s

**Fig. 11.2.6**
**Cover with stiffening fitted normal to the axis of primary bending**

**Table 11.2.11 Steel pontoon cover webs and stiffeners**

| Symbols | Primary and secondary stiffening requirements |
|---|---|
| $A_s$ = shear area, in cm$^2$<br>$K$ = higher tensile steel factor, *see* Ch 2,1.2<br>$K_1$ = 1281<br>$C_1$ = 696<br>$I_0$ = moment of inertia at mid-span, in cm$^4$<br>$I_1$ = moment of inertia at supports, in cm$^4$<br>where<br>$I_1 > 0,05\, I_0$<br>$l_0$ = unsupported span, in metres, measured as shown in Fig. 11.2.7<br>$l_1$ = proportion of the span, in metres, measured as shown in Fig. 11.2.7. The depth and face area over the remainder of the span is assumed to be constant<br>$p$ = minimum design pressure, in kN/m$^2$, acting on the hatch covers as defined in Table 11.2.8<br>$Z_0$ = section modulus at mid-span, in cm$^3$<br>$Z_1$ = section modulus at supports, in cm$^3$<br>$C_H = 1 + \frac{8\alpha_H^3 (1 - \beta_H)}{0,2 + 3\sqrt{\beta_H}}$<br>$K_H = 1 + \frac{3,2\alpha_H - \gamma_H - 0,8}{7,0\gamma_H + 0,4}$<br>but not less than 1,0. To be specially considered when discontinuities in area of face material occur<br>$\alpha_H = \frac{l_1}{l_0}$ $\beta_H = \frac{I_1}{I_0}$ $\gamma_H = \frac{Z_1}{Z_0}$ | $Z_0 = \frac{p\, s\, l_0^2\, K_H\, k}{K_1}$ cm$^3$<br>$I_0 = \frac{p\, s\, l_0^3\, C_H}{C_1}$ cm$^4$<br>$A_S = \frac{0,01282 p\, s\, l_0}{\sigma_o}$ cm$^2$<br>NOTE<br>Where the ends of the secondary panel stiffeners are effectively bracketed or continuous, the values of modulus and inertia of the secondary panel stiffeners may be reduced respectively by 33% and 80%. |

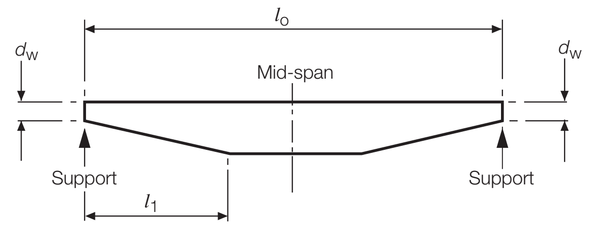


**Fig. 11.2.7**
**Diagrammatic profile of web or stiffener or portable beam**

## ■ Section 3
## Hatch beams and wood covers

### 3.1 Portable hatch beams

*3.1.1* The section modulus and moment of inertia of portable web plate beams stiffened at their upper and lower edges by continuous flat bars are to satisfy the requirements of 2.17 for pontoon covers. Alternatively, direct calculations may be used, provided the requirements of 2.17 for pontoon covers are complied with.

*3.1.2* The ends of web plates are to be doubled, or inserts fitted for at least 180 mm along length of web.

*3.1.3* At beams which carry the ends of wood or steel hatch covers, a vertical 50 mm flat is to be arranged on the upper face plate. The width of bearing surface for hatch covers is to be not less than 65 mm.

*3.1.4* Carriers or sockets, or other suitable arrangements, of suitable construction are to provide means for the efficient fitting and securing of portable hatch beams. The width of bearing surface is to be not less than 75 mm.

*3.1.5* Sliding hatch beams are to be provided with an efficient device for locking them in their correct fore and aft positions when the hatchway is closed.

### 3.2 Wood covers

*3.2.1* Wood covers are to have a finished thickness of not less than 60 mm in association with an unsupported span of not more than 1,5 m. Where the ‘tween deck height, measured vertically on the centreline of the ship from ‘tween deck to underside of the hatch cover stiffeners on deck above, exceeds 2,6 m, the thickness of the wood covers is to be increased at the rate of 16,5 per cent per metre excess in ‘tween deck height.

*3.2.2* The ends of all wood hatch covers are to be protected by encircling galvanised steel bands, about 65 mm wide and 33 mm thick, efficiently secured.

## ■ *Section 4*
## Hatch cover securing arrangements and tarpaulins

### 4.1 Cargo oil tank and adjacent spaces

*4.1.1* For access hatchways to cargo oil tanks and adjacent spaces, *see* Section 7.

### 4.2 Steel covers – Clamped and gasketed

*4.2.1* These requirements, unless stated otherwise, apply to steel hatch covers in Positions 1 and 2 fitted with gaskets and securing devices and situated above dry cargo holds.

*4.2.2* Where steel hatch covers are fitted to hatch openings on weather decks, the arrangements are to be such that weathertightness can be maintained. A sufficient number of securing devices is to be provided at each side of the hatch cover, considering the requirements of 2.9.4 to 2.9.6. This applies also to hatch covers consisting of several parts.

*4.2.3* The weight of the covers and weather loading may be transmitted to the ship's structure by means of continuous steel to steel contact of the cover skirt plate with the ship's structure in association with a maximum bearing pressure of 200 kgf/cm$^2$. Alternatively the weight may be transmitted by means of defined bearing pads. For covers loaded by containers or other cargo, the total load together with inertial forces generated by the ship's motion, are to be transmitted by means of defined bearing pads only.

*4.2.4* For the design of the securing devices against shifting, the horizontal mass forces $F_h = m\,a$ are to be calculated with the following accelerations:

$a_x$ = 0,2 $g$ in longitudinal direction
$a_y$ = 0,5 $g$ in transverse direction
$m$ = sum of mass of cargo lashed on the hatch cover and mass of hatch cover.

*4.2.5* For the transmission of the support forces resulting from the load cases specified in 2.3 and of the horizontal mass forces specified in 4.2.4, hatch cover supports are to be provided, which are to be designed such that the nominal surface pressures do not, in general, exceed the following values:

$p_{n\,max}$ = $dp_n$, in N/mm$^2$
$d$ = 3,75 – 0,015$L$
$d_{max}$ = 3,0
$d_{min}$ = 1,0 in general
= 2,0 for partial loading conditions, *see* Pt 4, Ch 8, 11.2.4
$p_n$ = *see* Table 11.4.1

For metallic supporting surfaces not subjected to relative displacements, the nominal surface pressure applies:

$p_{n\,max}$ = $3p_n$, in N/mm$^2$

The supports are to be designed such that the permissible stresses according to 2.4.1 are not exceeded.

**Table 11.4.1 Permissible nominal surface pressure $p_n$**

| Support material | $p_n$ in N/mm$^2$ when loaded by | |
|---|---|---|
| | Vertical force | Horizontal force (on stoppers) |
| Hull structural steel | 25 | 40 |
| Hardened steel | 35 | 50 |
| Plastic materials on steel | 50 | – |

*4.2.6* Drawings of hatch cover supports which specify the permitted maximum pressure related to long-term stress, given by the material manufacturer, must be submitted.

*4.2.7* Where large relative displacements of the supporting surfaces of hatch cover supports are to be expected, the use of material having low wear and frictional properties is recommended. If necessary, sufficient abrasive strength may be shown by tests demonstrating an abrasion of support surfaces of not more than 0,3 mm per year in service, at a total distance of shifting of 15 000 m/year.

*4.2.8* The substructures of the hatch cover supports must be of such a design that a uniform pressure distribution is achieved. Irrespective of the arrangement of stoppers, the supports must be able to transmit the following force $P_h$ in the longitudinal and transverse direction:

$$P_h = \mu \frac{P_v}{\sqrt{d}}$$

where
$P_v$ = vertical supporting force
$\mu$ = frictional coefficient
= 0,5 in general

For non-metallic, low-friction support materials on steel, the friction coefficient may be reduced, but is not to be less than 0,35. The substructures are to be designed such that the permissible stresses according to 2.4.1 are not exceeded.

*4.2.9* For substructures and adjacent structures of supports subjected to horizontal forces $P_h$, as defined in 4.2.8, a fatigue strength analysis is to be carried out.

*4.2.10* Hatch covers are to be sufficiently secured against horizontal shifting. Stoppers are to be provided for hatch covers on which cargo is carried. The greater of the loads resulting from 2.3.3 and 4.2.4 is to be applied for the dimensioning of the stoppers and their substructures. The permissible stress in stoppers and their substructures in the cover and in the coamings is to be determined according to 2.4.1. In addition, the provisions in 4.2.5 are to be observed.

*4.2.11* The sealing is to be obtained by a continuous gasket of relatively soft elastic material compressed to achieve the necessary weathertightness. Similar sealing is to be arranged between cross-joint elements. Where fitted, compression flat bars or angles are to be well rounded where in contact with the gasket and are to be made of a corrosion-restraint material or suitably protected against corrosion.

*4.2.12* Special consideration is to be given to the gasket and securing arrangements in ships with large relative movements between cover and ship structure or between cover elements. The relative horizontal and vertical deflections are to be calculated and submitted with the hatch cover plans. Where applicable, deflections due to thermal effects and internal pressure loads are also to be included.

*4.2.13* The suitability of the gasket material and the securing adhesive is the responsibility of the Builder and Owner. When selecting such material, consideration is to be given to its suitability for the environmental conditions likely to be experienced by the ship and its compatibility with the cargo carried. The material and form of gasket selected are to be considered in conjunction with the type of cover, the securing arrangement and the expected relative movement between cover and ship structure. The gasket is to be effectively secured to the cover.

*4.2.14* Drainage is to be arranged inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming; drain openings are to be provided at appropriate positions of the drain channels. This requirement need not be complied with for special ships carrying container cargoes when the requirements of Pt 4, Ch 8,11 are satisfied.

*4.2.15* Where the arrangement includes continuous steel to steel contact between hatch cover and coaming or between hatch cover and ship structure or at cross-joints, drainage on both sides of the gasket is to be provided.

*4.2.16* Drain openings are to be arranged at the ends of drain channels and are to be provided with non-return valves for preventing ingress of water from outside.
The following requirements are to be complied with:

(a) If manufactured from steel, the minimum drain pipe wall thickness is to be not less than 4,5 mm.
(b) If not manufactured from steel, details of the drain, including the material specification, method of manufacture and details of any tests carried out, are to be submitted for consideration.
(c) The drains are to be securely attached to the hatch coaming and adequately protected if in an exposed position.
(d) When the drain is fitted to a hold also designed to carry liquids, a shut-off valve is to be incorporated into the assembly.
(e) Drain openings in hatch coamings are to be arranged with sufficient distance to areas of stress concentration (e.g., hatch corners, transitions to crane posts).

*4.2.17* Panel hatch covers are to be secured by appropriate devices (bolts, wedges or similar) suitably spaced alongside the coamings. The securing devices are not to have a vertical clearance but are to be pre-tensioned when the cover is in the closed position. The devices are also to be arranged in close proximity horizontally to the gasket. Arrangement and spacing are to be determined with due attention to the effectiveness for weathertightness, depending upon the type and the size of the hatch cover, as well as on the stiffness of the cover edges between the securing devices. A minimum of two securing devices for each side of a panel are to be fitted. The securing devices should be arranged as close to the panel corners as is practicable.

*4.2.18* Between cover and coaming and at cross-joints, a gasket pressure sufficient to obtain weathertightness is to be maintained by the securing devices. This pressure is to be specified. Securing devices of a design other than rod or bolts will be specially considered, *see* 4.2.26.

*4.2.19* The net sectional area of each securing device is to be not less than:

$$A = \frac{1{,}4 S_1 W_1}{50 f} \text{ cm}^2 \quad \left( \frac{1{,}4 S_1 W_1}{5{,}1 f} \text{ cm}^2 \right)$$

where

$$f = \left( \frac{\sigma_c}{235} \right)^e$$

$S_1$ = spacing between securing devices, in metres, not to exceed 6 m and not to be taken less than 2 m
$W_1$ = the gasket loading per unit length, in N/cm (kgf/cm), but not less than 50 N/cm (5,1 kgf/cm)
$\sigma_c$ = specified minimum upper yield stress in N/mm$^2$ (kgf/mm$^2$) of the steel used for cleats or securing devices, to be taken not greater than 70 per cent of the ultimate tensile strength
$e$ = 0,75 for $\sigma_c \geq 235$ (24)
= 1,0 for $\sigma_c < 235$ (24).

*4.2.20* Rods or bolts are to have a gross diameter not less than 19 mm for hatchways exceeding 5 m$^2$ in area.

*4.2.21* In order to ensure compression between gasket and compression bar along the full length, the cover edge stiffness is to be examined. The inertia of the cover edge is to be not less than:

$$I_E = 0{,}6 W_1 S_1^4 \quad \text{cm}^4$$

$$(I_E = 5{,}89 W_1 S_1^4 \quad \text{cm}^4)$$

where

$W_1$ and $S_1$ are as defined in 4.2.12.

*4.2.22* Securing devices are to be constructed of reliable design and securely attached to the hatchway coamings, decks or covers. Individual securing devices on each cover are to have approximately the same stiffness characteristics.

*4.2.23* Where rod cleats are fitted, resilient washers or cushions are to be incorporated.

*4.2.24* Where hydraulic cleating is adopted, a positive means is to be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

*4.2.25* The cross-joints of multi-panel covers are to be arranged with wedges, or locators (male and female) to retain the hatch covers in the correct sealing position, the number and spacing are to be arranged to suit the size and type of cover, gasket arrangements and stiffness of cover edges at cross-joints. Means are also to be provided to prevent excessive relative vertical deflections between loaded and unloaded panels. The arrangement of the gasket retaining angle and the compression bar at the cross-joints is to be such that the gasket compression is maintained between loaded and unloaded panels.

*4.2.26* In addition to the requirements given above, all hatch covers, especially those carrying deck cargo are to be effectively secured against horizontal shifting due to the horizontal forces arising from the ship motions.

*4.2.27* To prevent damage to hatch covers and ship structure, the location of stoppers is to be compatible with the relative movements between hatch covers and ship structure. The number should be as small as practically possible.

*4.2.28* Towards the ends of the ship, vertical acceleration forces may exceed gravity forces. The resulting lifting forces must therefore be also considered when dimensioning the securing devices. Also lifting forces from cargo secured on the hatch cover during rolling are to be taken into account.

*4.2.29* Hatch coamings and supporting structure are to be adequately stiffened to accommodate the loading from hatch covers and cargo carried thereon.

*4.2.30* Upon completion of installation of hatch covers, a hose test with a pressure of water as specified in Table 1.8.1 in Chapter 1 is to be carried out. Alternative methods of tightness testing will be considered. This does not apply to covers with reduced securing arrangements as specified in Pt 4, Ch 8,11.

*4.2.31* All hatch covers are to be tested to prove satisfactory operation.

*4.2.32* It is recommended that ships with steel hatch covers are supplied with an operation and maintenance manual including:

(a) opening and closing instructions;
(b) maintenance requirements and specifications for packings, securing devices and operating items;
(c) cleaning instructions for the drainage system;
(d) corrosion prevention instructions;
(e) list of spare parts.

*4.2.33* The spacing and size of securing devices in hatch covers for holds which may be flooded and used for ballast tanks and holds in OBO, ore or oil and similar types of ship are to correspond to the reaction forces at the cover edges found by calculation. The loading is to be as required by Pt 4, Ch 7,12.4.1(c)

The permissible stress in the securing devices is not to exceed the following:

$\sigma_e = 0{,}9 \times 235\, f$ N/mm$^2$

where

$f$ = material factor as defined in 4.2.19
$\sigma$ = bending stress in N/mm$^2$
$\sigma_e$ = equivalent stress, in N/mm$^2$
$= \sqrt{(\sigma^2 + 3\tau^2)}$
$\tau$ = shear stress in N/mm$^2$.

*4.2.34* On tank hatch covers in ‘tween decks the maximum spacing of cleats is to be 600 mm, but cleats are to be arranged as close to the corners as practicable.

*4.2.35* Steel hatch covers with special sealing arrangements, insulated covers, flush hatch covers, and covers having coamings less than required by 5.1, will be specially considered.

*4.2.36* The material and weld specifications of stoppers and securing devices are to be shown in the drawings of the hatch covers.

*4.2.37* Securing devices of special design in which significant bending or shear stresses occur may be designed as anti-lifting devices according to Pt 4, Ch 8,11.2.5. The packing line pressure, as defined in 4.2.12, multiplied by the spacing between securing devices, as defined in 4.2.12, is to be applied as design load.

### 4.3 Portable covers – Tarpaulins and battening devices

*4.3.1* At least two layers of tarpaulin in good condition are to be provided for each hatchway in Positions 1 and 2.

*4.3.2* Tarpaulins are to be free from jute, waterproof and of ample strength. The minimum mass of the material before treatment is to be 0,65 kg/m$^2$ if the material is to be tarred, 0,60 kg/m$^2$ if to be chemically dressed, or 0,55 kg/m$^2$ if to be dressed with black oil. A certificate to this effect is to be supplied by the makers of the tarpaulins. Special consideration will be given to the use of synthetic materials for tarpaulins.

*4.3.3* Cleats are to be of an approved pattern, at least 65 mm wide, with edges so rounded as to minimise damage to the wedges, and are to be spaced not more than 600 mm from centre to centre: the first and last cleats along each side or end are to be not more than 150 mm from the hatch corners. Cleats should be so set as to fit the taper of the wedges.

*4.3.4* Battens and wedges shall be efficient and in good condition. Wedges are to be of tough wood, generally not more than 200 mm in length and 50 mm in width. They should have a taper of not more than 1 in 6 and should not be less than 13 mm at the point.

*4.3.5* For all hatchways in Positions 1 and 2, steel bars or other equivalent means are to be provided in order to secure each section of hatch covers efficiently and independently after the tarpaulins are battened down. Hatch covers of more than 1,5 m in length are to be secured by at least two such securing appliances. Where hatchway covers extend over intermediate supports, steel bars or their equivalent are to be fitted at each end of each section of covers. At all other hatchways in exposed positions on weather decks, ring bolts or other fittings suitable for lashings are to be provided.

### 4.4 Packing material

*4.4.1* Packing material is to be suitable for all expected service conditions of the ship and is to be compatible with the cargoes to be transported. The packing material is to be selected with regard to dimensions and elasticity in such a way that expected deformations can be carried. Forces are to be carried by the steel structure only.

*4.4.2* Packing material is to be compressed so as to give the necessary tightness effect for all expected operating conditions. Special consideration will be given to the packing arrangement in ships with large relative movements between hatch covers and coamings or between hatch cover sections.

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## ■ *Section 5*
## Hatch coamings

### 5.1 General

*5.1.1* The height of coamings above the upper surface of the deck, measured above sheathing if fitted, for hatchways closed by portable covers secured weathertight by tarpaulins and battening devices, is to be not less than:

600 mm at Position 1,
450 mm at Position 2.

*5.1.2* The height of coamings of hatchways situated in Positions 1 and 2 closed by steel covers fitted with gaskets and clamping devices is to be as specified in 5.1.1, but may be reduced, or the coamings may be omitted entirely, if the safety of the ship is not thereby impaired in any sea condition. Special attention will be given in such cases to the scantlings of the covers, to their gasketing and securing arrangements and to the drainage of recesses in the deck. The agreement of the National Authority concerned will also be required.

*5.1.3* The height of coamings may be required to be increased on ships of Type 'B-100' or Type 'B-60' where this is shown to be necessary by the floatability calculations required by the *International Convention on Load Lines, 1966.*

### 5.2 Construction

*5.2.1* Vertical cargo hatch coamings 600 mm or more in height are to be stiffened on their upper edges by a horizontal bulb flat or equivalent which is to be not less than 180 mm in width for ships where *L* is greater than 75 m. Additional support is to be afforded by fitting brackets or stays from the bulb flat to the deck at intervals of not more than 3 m. Each bracket or stay is to be aligned with suitable underdeck stiffeners and is to have a softened nose.

*5.2.2* Vertical coamings less than 600 mm in height are to be stiffened at their upper edge by a substantial rolled or fabricated section. Additional support is to be arranged as required by 5.2.2.

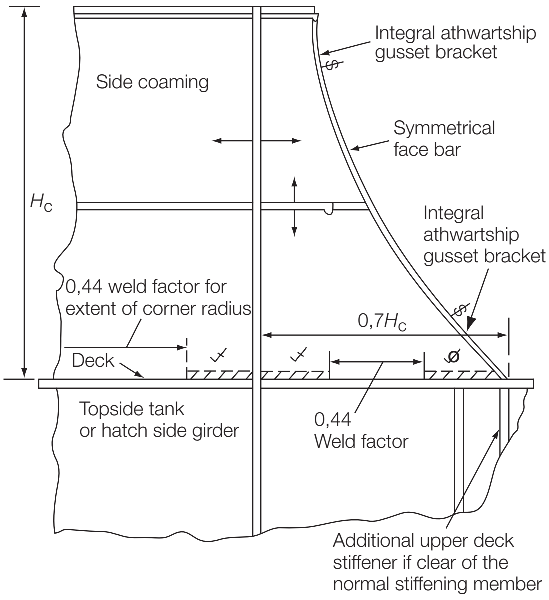
*5.2.3* Cargo hatchways on other decks, in positions not specified in Ch 1,6.5, are to be suitably framed.

*5.2.4* The scantlings and arrangements of hatch coamings acting as girders will be specially considered. The coamings are to be arranged with intermediate continuous horizontal stiffeners supported by the bracket stays.

*5.2.5* Sloped cargo hatch coamings will be specially considered. In general, the sloped coaming arrangement is to be restricted to the hatch side coamings with vertical coamings at the ends. The sloped coaming is not to have a knuckle and the angle to the vertical is not to exceed 30°. The scantlings are to be in accordance with 5.2.1, 5.2.2 and 5.3, except that the end coamings are to be increased by 20 per cent for a distance of 0,15*b* from the side coamings where *b* is the width of the hatchway at the deck. Particular care is to be taken where the proposed loadings exceed those given in 2.3 and Ch 3,5, and where the coamings are not in alignment with the topside tank vertical strake in bulk carriers.

*5.2.6* A radiused coaming plate at the corner junction of the longitudinal and transverse cargo hatch coamings is acceptable for ships where $L \leq 90$ m and the heights of coamings are not in excess of that specified in 5.1.1. Where $L > 90$ m the corner junctions are to be rectangular and arranged with continuation brackets as required by 5.2.8.

*5.2.7* The deck plating is to extend inside the coamings and the side coamings are to be extended in the form of tapered brackets. A recommended arrangement is shown in Fig. 11.5.1. Continuation brackets are also to be arranged athwartships in line with the hatch end coamings and the under deck transverse. In bulk carriers the athwartship brackets, in conjunction with the hatch end beams should be arranged to achieve a satisfactory overlap with the top side tank transverses. In cases where the hatch end beam is formed by the transverse bulkhead top stool the horizontal knuckle of the stool should be arranged well clear of the topside tank knuckle line.


Integral athwartship gusset bracket
Side coaming
Symmetrical face bar
$H_C$
Integral athwartship gusset bracket
0,44 weld factor for extent of corner radius
$0,7H_C$
Deck
Topside tank or hatch side girder
0,44 Weld factor
Additional upper deck stiffener if clear of the normal stiffening member

✓ Full penetration weld for a distance of $0,2H_C$ at hatch side, and end coamings and side continuation brackets

⌀ Full penetration weld for a distance of $0,15H_C$ from toe of side coaming continuation bracket and for connection of athwartship gusset bracket to deck

**Fig. 11.5.1**
**Coaming continuation bracket – Recommended arrangement**

*5.2.8* In bulk carriers where the hatch side coaming does not align with the topside tank vertical strake the arrangement and scantlings will be specially considered. In general, suitable underdeck girders and cantilever brackets are to be arranged taking into consideration the hatch cover loading. The underdeck girders are to continue beyond the hatch end for a distance of $2H_c$ mm. Alternative arrangements incorporating bulkhead top stool structure or cross-deck structure will be considered.

*5.2.9* Extension brackets or rails arranged approximately in line with the cargo hatch side coamings and intended for the stowage of steel covers are not to be welded to a deckhouse, masthouse or to each other unless they form part of the longitudinal strength members.

*5.2.10* The arrangement and scantlings of continuous hatchway coamings on the strength deck will be specially considered. The material of the coamings is to comply with Tables 2.2.1 and 2.2.2 in Chapter 2 and is to be of the same strength level as the deck plating. Discontinuous coamings of length greater than 0,09*L* are also to satisfy this requirement.

*5.2.11* Where containers are carried on multi-panel hatch covers, the hatch coaming in way of the loaded panel will be required to be reinforced to resist the lateral loads imposed on the coaming due to rolling of the ship. Thrust blocks are to be fitted on the coaming rest bar to prevent the covers from moving. Where one-piece hatch covers are fitted with locating devices, the coamings are to be reinforced in way of the locators.

*5.2.12* Cut outs in the top of hatch coamings are to be avoided. Where these are necessary for the securing devices they are to be circular or elliptical in shape. Also any local reinforcements should be given a tapered transition in the longitudinal direction with a taper the rate of which should not exceed 1 in 3. Cut-outs and drain holes are to be avoided in the hatch side coaming continuation brackets. Where these are necessary the size, shape and position will be specially considered.

*5.2.13* Material for hatch coamings is to be steel, according to the requirements for ship's hull. Alternative materials will be subject to special consideration.

*5.2.14* Secondary stiffeners of hatch coamings are to be continuous over the breadth and length of hatch coamings.

*5.2.15* Longitudinal hatch coamings with a length exceeding 0,1*L* m are to be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets they are to be connected to the deck by full penetration welds of minimum 300 mm in length.

*5.2.16* Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions. Structures under deck are to be checked against the load transmitted by coaming stays.

*5.2.17* On ships carrying cargo on deck, such as timber, coal or coke, coaming stays are to be spaced not more than 1,5 m apart.

*5.2.18* Coaming plates are to extend to the lower edge of the deck beams; they are to be flanged or fitted with face bars or half-round bars. Fig.11.5.2 gives an example.

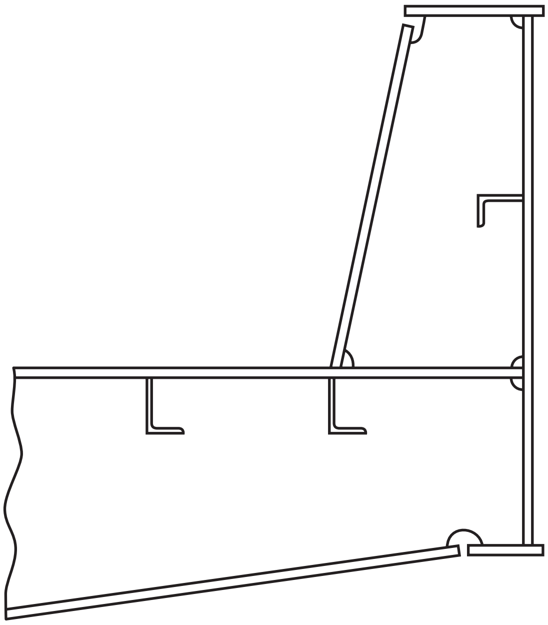


**Fig. 11.5.2**
**Example for the extent of coaming plates**

### 5.3 Strength criteria

*5.3.1* The strength requirements in this Section are applicable to hatch coamings of stiffened plate construction.

*5.3.2* The local net plate thickness of weather deck hatch coamings is not to be less than the larger of the following values:

$$t = 0{,}0142 s \sqrt{\frac{p_A}{0{,}95\,\sigma_o}} \text{ in mm}$$

$$t_{min} = 6 + \frac{L_1}{100} \text{ in mm}$$

where

$s$ = stiffener spacing, in mm

$L_1$ = $L$ need not be taken greater than 300 metres

$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3

Longitudinal strength aspects are to be observed.

*5.3.3* Secondary stiffeners of coamings must be continuous at the coaming stays. For stiffeners with both ends constrained, the elastic net section modulus $Z$ in cm$^3$ and net shear area $A_S$ in cm$^2$, calculated on the basis of net thickness, are not to be less than:

$$Z = \frac{0{,}083}{\sigma_o} s\, l^2\, p_A \ \text{cm}^3$$

$$A_s = \frac{0{,}01 s\, l\, p_A}{\sigma_o} \ \text{cm}^2$$

where

$l$ = secondary stiffener span, in metres, to be taken as the spacing of coaming stays

$s$ = stiffener spacing in mm

$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.4* For sniped stiffeners at coaming corners, section modulus and shear area at the fixed support are to be increased by 35 per cent. The gross thickness of the coaming plate at the sniped stiffener end is not to be less than:

$$t = 19{,}6 \sqrt{\frac{0{,}001 s\, p_A\, (l - 0{,}0005\, s)}{\sigma_o}} \quad \text{N mm}$$

where

$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.5* Coaming stays are to be designed for the loads transmitted through them, and permissible stresses according to 2.4.1.

*5.3.6* The net section modulus $Z$ of coaming stays, with a height of $h_s < 1{,}6$ m and which are to be designed for the load $p_A$, is not to be less than:

$$Z = \frac{526}{\sigma_o} e\, h_s^2\, p_A \quad \text{in cm}^3$$

where

$e$ = spacing of coaming stays, in metres

$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.7* Coaming stays of coamings having a height of 1,6 m or more are to be designed using direct calculations under consideration of the permissible stresses according to 2.4.1. The effective breadth of the coaming plate is not to be larger than the effective plate breadth according to 2.10.2.

*5.3.8* Coaming stays are to be supported by appropriate substructures. Face-plates may be included in the calculation only if an appropriate substructure is provided and welding ensures an adequate joint.

*5.3.9* The web gross thickness of coaming stays at the root point is not to be less than:

$$t_w = \frac{2\, e\, h_s\, p_A}{\sigma_o\, h_w} + t_c$$

where

$h_w$ = web height of coaming stay at its lower end, in metres

$t_c$ = corrosion addition, in mm, according to 1.1.13

$p_A$ = pressure, in kN/m$^2$, as defined in 2.3.3.

*5.3.10* Webs of coaming stays are to be connected to the deck by fillet welds on both sides with a throat thickness of $a = 0{,}44 t_w$.

*5.3.11* For coaming stays which transfer friction forces at hatch cover supports, sufficient fatigue strength is to be verified, *see* 4.2.5 to 4.2.8.

*5.3.12* Hatch coamings which are part of the longitudinal hull structure are to be designed according to the requirements for longitudinal strength in Pt 3, Ch 4.

*5.3.13* For structural members welded to coamings and for cut-outs in the top of coamings, sufficient fatigue strength is to be verified.

### 5.4 Rest bars in hatchways

*5.4.1* Rest bars are to provide at least 65 mm bearing surface and are to be aligned if required to suit the slope of the hatches.

### 5.5 Loading in excess of Rule requirements

*5.5.1* For weather deck hatch side coamings forming part of a hatch side girder subjected to loading exceeding that defined in 2.3, *see* Pt 4, Ch 1,4.

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## ■ *Section 6*

## Miscellaneous openings

### 6.1 Small hatchways on exposed decks

*6.1.1* Hatches which:

- are designed for access to spaces below the deck;
- are capable of being closed weathertight or watertight, as applicable;
- have an opening 2,5 m$^2$ or less;
- are located on the exposed deck over the forward 0,25$L$ of the ship's rule length;
- are on a ship of sea-going service of length 80 m or more, where the height of the exposed deck in way of the hatch is less than 0,1$L$ or 22 m above the summer load waterline, whichever is the lesser;

are to comply with the requirements of 6.6. All other small hatchways or access openings in the positions defined in 1.1.6 are to comply with the following requirements.

*6.1.2* The number and size of hatchways and other access openings are to be kept to the minimum consistent with the satisfactory operation of the ship.

*6.1.3* The height of coamings is to be in accordance with 5.1.1. Lower heights may be considered in relation to operational requirements and the nature of the spaces to which access is given.

*6.1.4* Rope hatches may be accepted with reduced coamings, but generally not less than 380 mm, provided they are well secured and closed before the ship leaves port. A suitable notice is to be displayed at the hatch stating that it is to be closed whilst the ship is at sea.

*6.1.5* The thickness of the coamings is to be not less than the Rule minimum thickness for the deck inside line of openings for that position, or 11 mm, whichever is the lesser. Stiffening of the coaming is to be appropriate to its length and height.

*6.1.6* Hatch covers are to be of steel, weathertight and generally hinged. The means of securing are to be such that weathertightness can be maintained in any sea condition. Where toggles are fitted, their diameter and spacing are to be in accordance with ISO Standard or equivalent.

*6.1.7* Hinges are not to be used as securing devices unless specially considered.

*6.1.8* The thickness of covers is to be not less than the Rule minimum thickness inside the line of openings for the deck at that point, or 8 mm, whichever is the lesser.

*6.1.9* The covers are to be adequately stiffened.

*6.1.10* Escape hatches are to be capable of being opened from either side.

*6.1.11* Small hatches, including escape hatches, are to be situated clear of cargo containment areas, particularly in the case of offshore supply ships.

*6.1.12* Where portable plates are required in decks for unshipping machinery, or for other similar reasons, they may be accepted provided they are of equivalent strength to the unpierced deck and are secured by gaskets and closely spaced bolts at a pitch not exceeding five diameters.

*6.1.13* Satisfactory means are to be provided to prevent inadvertent flooding of chain lockers. *See* Ch 13,8.10.5 and 8.10.7.

*6.1.14* Where permitted by the National Authority, access hatch coaming heights may be reduced on ships engaged on protected or extended protected water service. Coaming heights are to be as high as practicable with a minimum height of 230 mm.

## 6.2 Manholes and flush scuttles

*6.2.1* Manholes and flush scuttles fitted in Positions 1 and 2, or within superstructures other than enclosed superstructures, are to be closed by substantial covers capable of being made watertight. Unless secured by closely spaced bolts, the covers are to be permanently attached.

## 6.3 Hatchways within enclosed superstructures or 'tween decks

*6.3.1* The requirements of 6.1 are to be complied with where applicable.

*6.3.2* Access hatches within a superstructure or deckhouse in Positions 1 or 2 need not be provided with means for closing if all openings in the surrounding bulkheads have weathertight closing appliances.

## 6.4 Companionways, doors and accesses on weather decks

*6.4.1* Companionways on exposed decks are to be of equivalent construction, weathertightness and strength to a deckhouse in the same position and effectively secured to the deck.

*6.4.2* Access openings in:
(a) bulkheads at ends of enclosed superstructures;
(b) deckhouses or companionways protecting openings leading into enclosed superstructures or to spaces below the freeboard deck; and
(c) deckhouse on a deckhouse protecting an opening leading to a space below the freeboard deck;

are to be fitted with doors of steel or other equivalent material, permanently and strongly attached to the bulkhead and framed, stiffened and fitted so that the whole structure is of equivalent strength to the unpierced bulkhead, and weathertight when closed. The doors are to be gasketed and secured weathertight by means of clamping devices or equivalent arrangements, permanently attached to the bulkhead or to the door. Doors are generally to open outwards and are to be capable of being operated and secured from both sides. The sill heights are to be as required by 6.4.5. *See also* Section 7 and Pt 4, Ch 9,13 and Ch 11,1 and the Rules for Ships for Liquid Chemicals, Chapter 3 concerning access openings in tankers, chemical tankers and ore or oil ships. Double doors are to be equivalent in strength to the unpierced bulkhead, and in Position 1, a centre pillar is to be provided which may be portable.

*6.4.3* Elsewhere doors may be of hardwood not less than 50 mm in thickness or of equivalent material and strength.

*6.4.4* Fixed lights in doors in Positions 1 and 2 are to comply with the requirements for side scuttles as given in 6.5.1 and 6.5.2. Hinged steel deadlights may be external.

*6.4.5* The height of doorway sills above deck sheathing, if fitted, is to be not less than 600 mm in Position 1, and not less than 380 mm in Position 2.

*6.4.6* Where access is provided from the deck above as an alternative to access from the freeboard deck, the height of sill into a bridge or a poop is to be not less than 380 mm. The same requirement applies to deckhouses on the freeboard deck. The sill height for doorways in a forecastle, if protecting a companionway, is to be 600 mm regardless of whether or not access is provided from above. If not protecting a companionway, the sill height may be 380 mm.

*6.4.7* When the closing appliances of openings in superstructures and deckhouses do not comply with 6.4.2, interior deck openings are to be treated as if exposed on the weather deck.

*6.4.8* Where an access opening, in the top of a deckhouse situated on a raised quarterdeck, gives access below the freeboard deck or to an enclosed superstructure, the closing appliances in the surrounding bulkheads are not required to be gasketed, provided the raised quarterdeck is at least standard height, and the deckhouse is at least standard superstructure height.

*6.4.9* The height of door sills may be required to be increased on ships of Type 'A', Type 'B-100' or Type 'B-60' where this is shown to be necessary by the floatability calculations required by the *International Convention on Load Lines, 1966.*

*6.4.10* Direct access from the freeboard deck to the machinery space through exposed casings is not permitted on ships of Type 'A', Type 'B-100' or Type 'B-60'. A door complying with 6.4.2 may, however, be fitted in an exposed machinery casing on these ships, provided that it leads to a space or passageway which is of equivalent strength to the casing and is separated from the machinery space by a second weathertight door complying with 6.4.2. The outer and inner weathertight doors are to have sill heights of not less than 600 mm and 230 mm, respectively and the space between is to be adequately drained by means of a screw plug or equivalent.

*6.4.11* For a Type 'A' ship with freeboards assigned greater than, or equal to, Type 'B', inner doors are not required for direct access to the engine-room.

*6.4.12* If internal access is provided from a wheelhouse in Position 2, or below, to spaces below the weather deck either directly or through other spaces, the opening should be protected by a hinged weathertight cover adequately secured, fitted on a coaming appropriate to its position, or by an equivalent arrangement, and the space adequately drained.

*6.4.13* In way of a moonpool, where a working or platform deck is provided below the weather deck, openings in the surrounding bulkheads are to be kept to a minimum. Access or companionway openings are to be provided with weathertight closing appliances as for an exposed superstructure bulkhead, with 600 mm high coamings.

*6.4.14* Where portable plates are required in casings for unshipping machinery, or for other similar reasons, they may be accepted provided they are of equivalent strength to the unpierced bulkhead and are secured by gaskets and close spaced bolts at a pitch not exceeding five diameters.

*6.4.15* The sill heights of accesses closed by covers which are secured by closely spaced bolts or otherwise kept permanently closed at sea will be specially considered.

*6.4.16* Where permitted by the National Authority, companionway coaming heights may be reduced on ships engaged on protected or extended protected water service. Coaming heights are to be as high as practicable with a minimum height of 230 mm. Where the wheelhouse is on the freeboard deck, or located in the forward quarter of the ship's length, with internal access below, a weathertight cover, fitted to a coaming not less than 230 mm high, is to be provided for the access. Alternatively, storm covers are to be provided for windows in exposed positions. The wheelhouse is to be adequately drained.

### 6.5 Side scuttles, windows and skylights

*6.5.1* Side scuttles are defined as being round or oval openings with an area not exceeding 0,16 $m^2$.

*6.5.2* Windows are defined as being rectangular openings generally, and round or oval openings with an area exceeding 0,16 $m^2$.

*6.5.3* A plan showing the location of side scuttles and windows is to be submitted. Attention is to be given to any relevant Statutory Requirements of the National Authority of the country in which the ship is to be registered.

*6.5.4* Side scuttles and windows together with their glasses and deadlights if fitted, are to be of an approved design or in accordance with a recognised National or International Standard, *see also* Pt 4, Ch 4,6.3 for offshore supply ships.

*6.5.5* Side scuttles to spaces below the freeboard deck, or to spaces within the first tier of enclosed superstructures, or to first tier deckhouses on the freeboard deck protecting openings leading below or considered buoyant in stability calculations, are to be fitted with efficient, hinged, inside deadlights and capable of being effectively closed and secured watertight.

*6.5.6* Deadlights are to be capable of being closed and secured watertight if fitted below the freeboard deck or weathertight if fitted above.

*6.5.7* No side scuttle is to be fitted in such a position that its sill is below a line drawn parallel to the freeboard deck at side and having its lowest point 2,5 per cent of the breadth $B$ above the load waterline corresponding to the summer freeboard (or timber summer freeboard if assigned), or 500 mm, whichever is the greater distance, *see* Fig. 11.6.1.

*6.5.8* If the required damage stability or floatability calculations indicate that the side scuttles would become immersed at any intermediate stages of flooding or the final equilibrium waterline, these are to be of the non-opening type. Windows are not to be fitted in such locations.

*6.5.9* Windows are not to be fitted in machinery space boundaries. However this does not preclude the use of glass in control rooms within the machinery space.

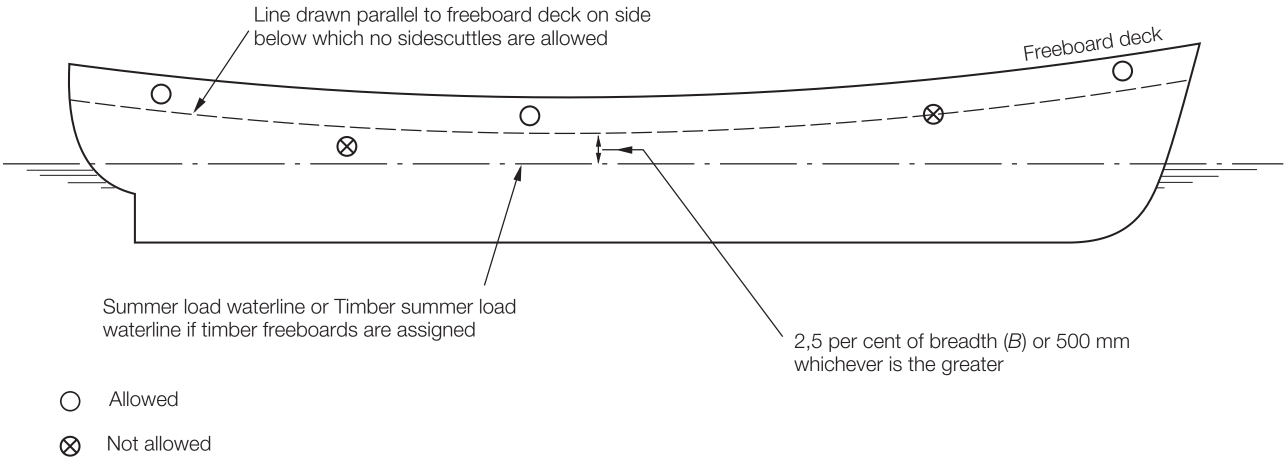

Line drawn parallel to freeboard deck on side below which no sidescuttles are allowed
Freeboard deck
Summer load waterline or Timber summer load waterline if timber freeboards are assigned
2,5 per cent of breadth (*B*) or 500 mm whichever is the greater
○ Allowed
⊗ Not allowed

**Fig. 11.6.1 Side scuttle positioning**

*6.5.10* If fitted in a deckhouse in Position 1, windows are to be provided with strong, hinged, steel, weathertight storm covers. However, if there is an opening leading below deck in this deckhouse, this opening is to be treated as being on an exposed deck and is to be protected as required by 6.4.2.

*6.5.11* Windows are not to be fitted below the freeboard deck, in first tier end bulkheads or sides of enclosed superstructures, or in first tier deckhouses that are considered buoyant in stability calculations.

*6.5.12* Side scuttles and windows at the shell in Position 2, protecting direct access below, are to be provided with strong permanently attached deadlights.

*6.5.13* Side scuttles and windows at the shell in Position 2, not protecting direct access below, are to be provided with strong portable steel covers for 50 per cent of each size, with means for securing at each side scuttle and window.

*6.5.14* Side scuttles and windows set inboard from the shell in Position 2, protecting direct access below, are either to be provided with strong permanently attached deadlights or, where they are accessible, strong permanently attached external steel storm covers instead of internal deadlights.

*6.5.15* Side scuttles and windows set inboard from the shell in Position 2, not protecting direct access below, do not require deadlights or storm covers.

*6.5.16* In Position 2, cabin bulkheads and doors are considered effective between side scuttles or windows and access below.

*6.5.17* Windows in the shell above Position 2 are to be provided with strong portable internal storm covers for 25 per cent of each size of window, with means of securing being provided at each window.

*6.5.18* Where windows are permitted in an exposed bulkhead on the weather deck in the forward $0{,}25L_L$, strong external storm covers which may be portable and stored adjacent are to be provided.

*6.5.19* Where the wheelhouse is in Position 2, in lieu of storm covers being provided for the wheelhouse windows, a weathertight cover, fitted to a coaming of not less than 230 mm in height around the internal stairway opening within the wheelhouse, may be accepted. If this arrangement is accepted, adequate means of draining the wheelhouse are to be provided.

*6.5.20* If necessary, for practical considerations, the storm covers may be in two parts.

*6.5.21* Deckhouses situated on a raised quarter deck may be treated as being in Position 2 as far as the provision of deadlights is concerned, provided the height of the raised quarter deck is equal to, or greater than, the standard height.

*6.5.22* Skylights, where fitted, are to be of substantial construction and securely attached to their coamings. The height of the lower edge of opening is to be as required by 5.1.1. The scantlings of the coaming are to be as required by this Section or Section 5, as appropriate. The thickness of glasses in fixed or opening skylights is to be appropriate to their size and position as required for side scuttles or windows. Glasses in any position are to be protected from mechanical damage, and where fitted in Positions 1 or 2 are to be provided with robust deadlights or storm covers permanently attached. Cargo pump room and machinery space skylights are not to contain glass.

*6.5.23* Skylights to cargo pump rooms are to be capable of being closed from outside the pump room.

*6.5.24* Laminated toughened safety glass may also be used for windows but the total thickness will need to be greater than that required for the equivalent sized window using toughened safety glass. The equivalent thickness of laminated toughened safety glass is to be determined from the following formula:

$$T_{L1}^2 + T_{L2}^2 + ....T_{Ln}^2 = T_S^2$$

where:

$n$ = number of laminates
$T_L$ = thickness of glass laminate
$T_S$ = thickness of toughened safety glass.

Alternative arrangements that do not meet the above thickness requirement will be specially considered, provided that equivalent strength and bending stiffness to that of a single, thermally toughened pane of thickness, $t_s$, can be demonstrated in a four-point bending test in accordance with EN-ISO 1288-3 or an equivalent recognised National or International Standard, using not less than ten samples. The lower limit of the 90 per cent confidence level interval for the laminated pane shall not be less than the same for monolithic toughened safety glass. Small scale punch test or ring-in-ring test methods shall not be used.

*6.5.25* Rubber frames are not acceptable for windows in Positions 1 and 2, and are not generally acceptable in any other position in external casings. Any proposals to fit rubber frames are to be submitted for consideration, and are to be acceptable to the administration. The proposed locations, frame dimensions, glass thicknesses and the results of any tests carried out, are to be forwarded.

## 6.6 Small hatchways on exposed fore decks

*6.6.1* For the application of the following requirements, *see* 6.1.1.

*6.6.2* The number and size of hatchways and other access openings are to be kept to the minimum consistent with the satisfactory operation of the ship.

*6.6.3* The height of coamings is to be in accordance with 5.1.1. Lower heights may be considered in relation to operational requirements and the nature of the spaces to which access is given.

*6.6.4* Rope hatches may be accepted with reduced coamings, but generally not less than 380 mm, provided they are well secured and closed before the ship leaves port. A suitable notice is to be displayed at the hatch stating that it is to be closed whilst the ship is at sea.

*6.6.5* Where permitted by the National Authority, access hatch coaming heights may be reduced on ships engaged on protected or extended protected water service. Coaming heights are to be as high as practicable with a minimum height of 230 mm.

*6.6.6* The thickness of the coamings is to be not less than the Rule minimum thickness for the deck inside line of openings for that position, or 11 mm, whichever is the lesser.

*6.6.7* The upper edge of the hatchway coamings is to be suitably reinforced by a horizontal section, normally not more than 170 to 190 mm from the upper edge of the coamings.

*6.6.8* Hatches are to be fitted with primary securing devices such that their hatch covers can be secured in place and weather-tight by means of a mechanism employing any one of the following methods:

(a) Butterfly nuts tightening onto forks (clamps),
(b) Quick acting cleats, or
(c) Central locking device.

Emergency escape hatches are excluded from options (a) and (b).

*6.6.9* Dogs (twist tightening handles) with wedges are not acceptable as primary securing devices.

*6.6.10* Escape hatches are to be capable of being opened from either side and are to have a quick-acting type securing device, e.g. one action wheel handle central locking device for latching/unlatching the hatch cover.

*6.6.11* For a primary securing method using butterfly nuts, the forks (clamps) are to be of robust design. They are to be designed to minimise the risk of butterfly nuts being dislodged while in use; by means of curving the forks upward, a raised surface on the free end, or a similar method. The plate thickness of unstiffened steel forks is not to be less than 16 mm. An example arrangement is shown in Fig. 11.6.3.

*6.6.12* The hatch cover is to be fitted with a gasket of elastic material. This is to be designed to allow a metal to metal contact at a designed compression and to prevent over compression of the gasket by green sea forces that may cause the securing devices to be loosened or dislodged. The metal-to-metal contacts are to be arranged close to each securing device in accordance with Fig. 11.6.2, and of sufficient capacity to withstand the bearing force.

*6.6.13* The primary securing method is to be designed and manufactured such that the designed compression pressure can be achieved by one person without the need of any tools.

*6.6.14* For small rectangular steel hatch covers, the plate thickness, stiffener arrangement and scantlings are to be in accordance with Table 11.6.1 and Fig. 11.6.2. Stiffeners, where fitted, are to be aligned with the metal-to-metal contact points required in 6.6.11, *see* Fig. 11.6.2. Primary stiffeners are to be continuous. All stiffeners are to be welded to the inner edge stiffener, *see* Fig. 11.6.3.

**Table 11.6.1 Scantlings for small steel hatch covers on exposed deck**

| Nominal size (mm x mm) | Cover plate thickness (mm) | Primary stiffeners | Secondary stiffeners |
|---|---|---|---|
| | | Flat bar (mm x mm); number | |
| 630 x 630 | 8 | – | – |
| 630 x 830 | 8 | 100 x 8;1 | – |
| 830 x 630 | 8 | 100 x 8;1 | – |
| 830 x 830 | 8 | 100 x 10;1 | – |
| 1030 x 1030 | 8 | 120 x 12;1 | 80 x 8;2 |
| 1330 x 1330 | 8 | 150 x 12;2 | 100 x 10;2 |

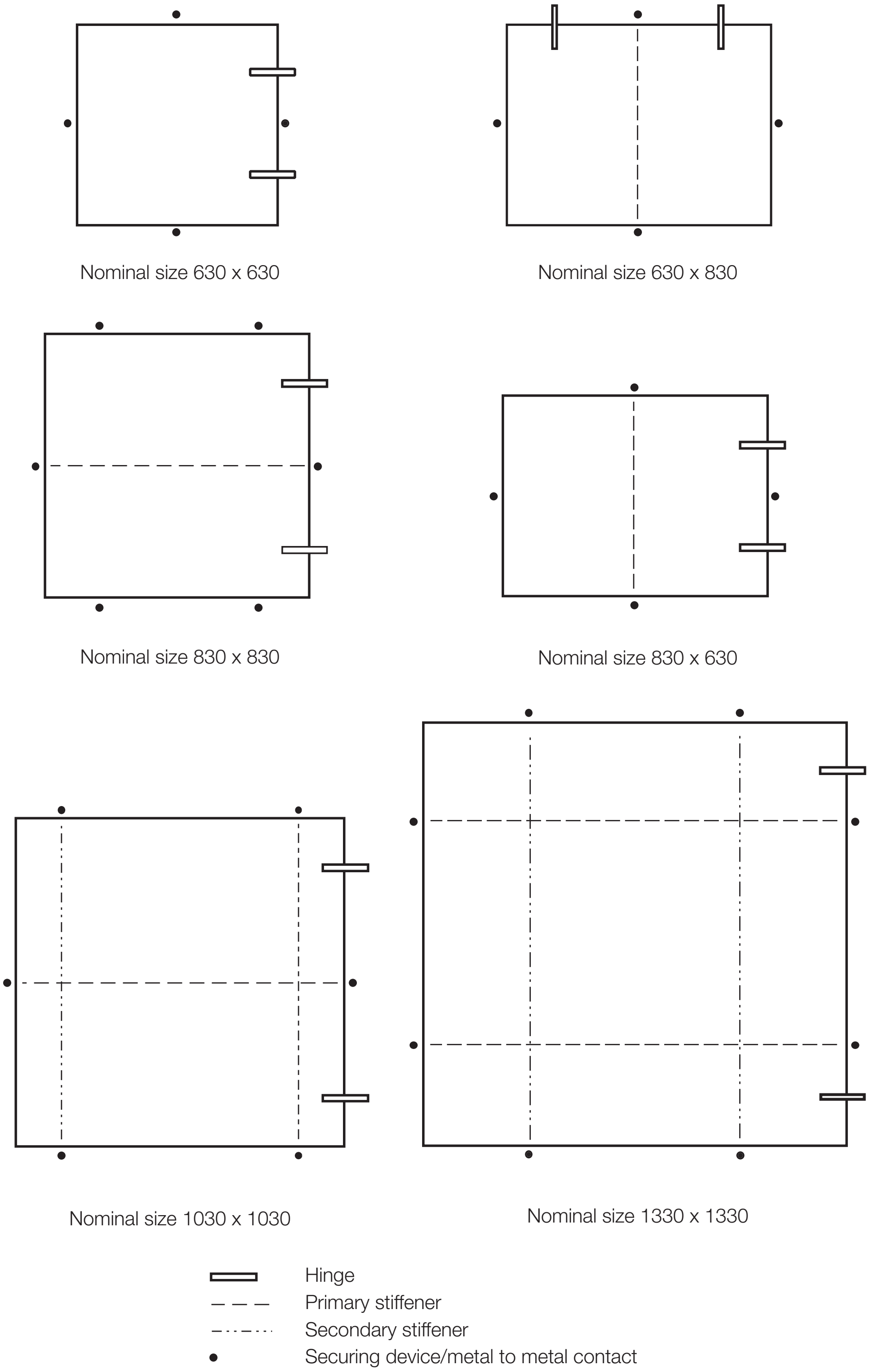
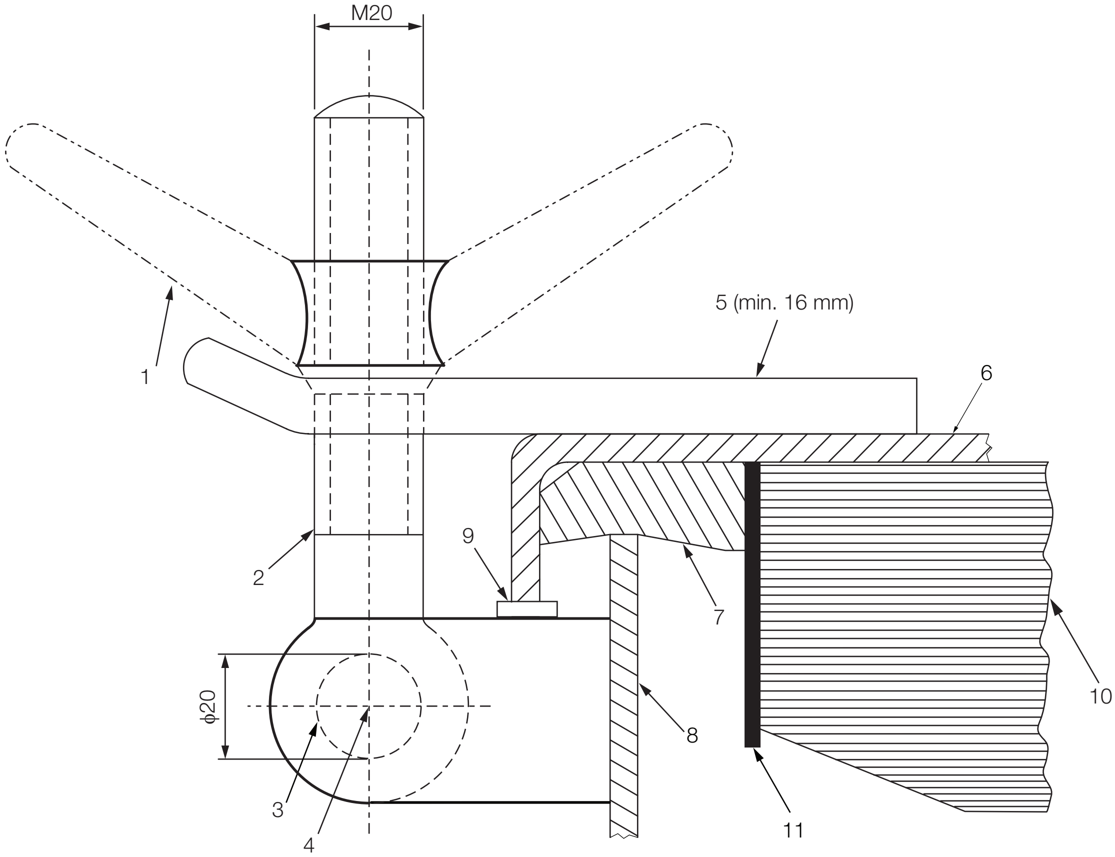


**Fig. 11.6.2 Arrangement of stiffeners**

*6.6.15* For hatch covers constructed of materials other than steel, the required scantlings are to provide equivalent strength.

*6.6.16* For small hatch covers of circular or similar shape, the cover plate thickness and reinforcement are to be of equivalent strength to that of the small rectangular steel hatch covers described in 2.2.1.

*6.6.17* For hatch covers located on the deck forward of the fore-most cargo hatch, the hinges are to be fitted such that the predominant direction of green sea will cause the cover to close. The hinges are normally to be located on the fore edge.



1. butterfly nut
2. bolt
3. pin
4. centre of pin
5. fork (clamp) plate
6. hatch cover
7. gasket
8. hatch coaming
9. bearing pad welded on the bracket of a toggle bolt for metal to metal contact
10. stiffener
11. inner edge stiffener

(Note: Dimensions in millimeters)

**Fig. 11.6.3 Example of a primary securing method**

*6.6.18* On small hatches located between the main hatches, for example between Numbers 1 and 2, the hinges are to be placed on the fore edge or outboard edge, whichever is practicable for protection from green water in beam sea and bow quartering conditions.

*6.6.19* Hatches, excluding emergency escape hatches, are to be fitted with an independent secondary securing device, e.g. by means of a sliding bolt, a hasp or a backing bar of slack fit, which is capable of keeping the hatch cover in place, even in the event that the primary securing device became loosened or dislodged. It is to be fitted on the side opposite to the hatch cover hinges.

*6.6.20* Small hatches, including escape hatches, are to be situated clear of cargo containment areas, particularly in the case of offshore supply ships.

*6.6.21* Where portable plates are required in decks for unshipping machinery, or for other similar reasons, they may be accepted provided they are of equivalent strength to the unpierced deck and are secured by gaskets and closely spaced bolts at a pitch not exceeding five diameters.

*6.6.22* Satisfactory means are to be provided to prevent inadvertent flooding of chain lockers, *see* Ch 13,8.10.5 and 8.10.7.

## ■ *Section 7*
## Tanker access arrangements and closing appliances

### 7.1 Materials

*7.1.1* Covers for access hatches, tank cleaning and other openings to cargo tanks and adjacent spaces are to be manufactured from steel complying with the Rules for Materials.

*7.1.2* Consideration will be given to the use of bronze, brass or other materials; however, aluminium alloy is not to be used for the covers of any openings to tanks.

*7.1.3* Synthetic materials will be considered, taking into account their fire resistance and physical and chemical properties in relation to the intended operating conditions. Details of the properties of the material, the design of the cover and the method of manufacture are to be submitted for approval.

*7.1.4* The hatch cover packing material is to be compatible with the cargoes to be carried and is to be efficiently held in place.

### 7.2 Cargo tank access hatchways

*7.2.1* Attention is drawn to IMO Resolutions concerning safe access to, and working in, large tanks.

*7.2.2* Oiltight hatchways are to be kept to the minimum size required to provide reasonable access and ventilation. Where tanks are large or subdivided by wash bulkheads, additional hatchways may be required. In determining the size and location of hatchways, consideration should be given to the handling of materials and staging for maintenance in the tank.

*7.2.3* The size and location of hatchways should also take into account access for personnel wearing breathing apparatus, and removal of injured personnel (possibly on a stretcher) from the bottom of the tank.

*7.2.4* The height of hatch coaming is to be not less than 600 mm, measured above the upper surface of the freeboard deck, unless a lower height is permitted by the Administration of the country in which the ship is to be registered.

*7.2.5* Taking account of sheer and camber, the height of any cargo tank hatch coaming is to be such as to ensure that the top of the hatch coaming is above the highest point of the tank over which it is fitted.

*7.2.6* The height of the coaming may be required to be increased if this is shown to be necessary by the floatability calculations required by the *International Convention on Load Lines, 1966.*

*7.2.7* The thickness of the coaming plate is to be not less than 10 mm, but may be required to be increased, and edge stiffening fitted, where the coaming height exceeds 600 mm.

*7.2.8* Unstiffened plate covers are to be not less than 12,5 mm in thickness, but if the area of the cover exceeds 1,2 $m^2$ this thickness may be required to be increased or stiffening fitted.

*7.2.9* Unstiffened covers are to be secured by fastenings spaced not more than 600 mm apart on circular hatchways. On rectangular hatchways the spacing of fastenings is generally not to exceed 450 mm, and the distance between hatch corners and adjacent fastenings is to be not more than 230 mm.

*7.2.10* The arrangement of fastenings on stiffened hatchway covers and covers of special design will be specially considered.

*7.2.11* Where the cover is hinged, adequate stiffening of the coaming and cover in way of the hinge is to be provided. In general, hinges are not to be used as securing devices for the cover.

### 7.3 Enlarged cargo tank access openings

*7.3.1* Proposals to fit enlarged cargo tank accesses closed by bolted plate covers will be considered. Such openings may be of extended dimensions for ease of access and evacuation of personnel, *see* 7.2.3, and may incorporate a smaller access hatch for normal use constructed as required by 7.2.

*7.3.2* The plate cover is to be not less than 15 mm in thickness and is to be secured by closely spaced studs to a ring of suitable dimensions, welded to the deck. The studs are not to penetrate the deck plating.

### 7.4 Miscellaneous openings

*7.4.1* Small openings for tank cleaning, ullage and similar purposes may be closed by flush covers which are to be not less than 12,5 mm in thickness and secured by studs not more than 100 mm apart. Studs are to be arranged in a ring of suitable width and thickness attached to the deck, and are not to penetrate the deck plating.

*7.4.2* Small diameter holes provided for staging wires are to be closed by plugs of an approved pattern. The plugs are to be provided with a thick washer of suitable material which is also compatible with the intended cargoes. Spare plugs equal to at least 10 per cent of the number of holes are to be provided and maintained on board, *see also* Pt 4, Ch 9,4. If these openings are threaded they are to be protected while in use with a protective sleeve of suitable material.

### 7.5 Access to spaces other than cargo tanks

*7.5.1* Access to clean ballast or dry tanks and to cofferdams may be either by access hatch or by manhole generally complying with the preceding requirements.

### 7.6 Equivalents

*7.6.1* Alternative access cover designs and securing arrangements will be considered on the basis of equivalence to the above requirements and taking into account any relevant National Requirements.

### 7.7 Other openings

*7.7.1* For access to structure within cargo tanks, *see* Pt 4, Ch 9,13.

## Section 8
## Side and stern doors and other shell openings

### 8.1 Symbols

*8.1.1* The symbols used in this Section are defined as follows:

$d$ = distance between closing devices, in metres

$k$ = material factor, *see* Ch 2,1.2, but is not to be taken less than 0,72 unless demonstrated otherwise by a direct strength analysis with regard to relevant modes of failure

$I$ = moment of inertia, in cm$^4$, of the stiffener or girder, in association with an effective width of attached plating determined in accordance with Ch 3,3

$\sigma$ = bending stress, in N/mm$^2$ (kgf/mm$^2$)

$\sigma_e$ = equivalent stress, in N/mm$^2$ (kgf/mm$^2$)

$= \sqrt{(\sigma^2 + 3\tau^2)}$

$\sigma_o$ = minimum yield stress of the bearing material, in N/mm$^2$ (kgf/mm$^2$)

$\tau$ = shear stress, in N/mm$^2$ (kgf/mm$^2$).

### 8.2 General

*8.2.1* These requirements cover cargo and service doors in the ship side (abaft the collision bulkhead) and stern area, below the freeboard deck and in enclosed superstructures.

*8.2.2* For the requirements of bow doors, *see* Pt 4, Ch 2,8.

*8.2.3* Side and stern doors are to be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure, *see also* Ch 1,6.3.2 and 6.4.2.

*8.2.4* In general, and for passenger ships in particular, the lower edge of door openings is not to be below a line drawn parallel to the freeboard deck at side, which has at its lowest point at least 230 mm above the upper edge of the uppermost Load Line.

*8.2.5* When the lower edge is below the line specified in 8.2.4, the arrangement will be specially considered. Special consideration is to be given to preventing the spread of leakage water over the deck. The reference to the uppermost Load Line is to be taken as the tropical fresh waterline or, if timber freeboards are assigned, the timber tropical fresh waterline.

*8.2.6* Watertight doors below the freeboard deck, with the exception of pilot doors which are to open inwards, are to open outwards. Weathertight doors are generally to be arranged to open outwards, however inward opening doors will be considered provided these satisfy the requirements of 8.2.7.

*8.2.7* Inward opening doors situated in the first two 'tween decks above the summer load waterline are to be fitted with a second independent securing device, such as a strongback or equivalent arrangement, capable of providing weathertight integrity. Where the consequences of water ingress due to failure of the door are minimal, such as a small pilot door giving access to a watertight trunk leading to the bulkhead deck, the required enhancements will be specially considered.

*8.2.8* For passenger ships the following are also applicable:

(a) Gangway, cargo and service ports fitted below the margin line, *see* Ch 3,4.3, are to satisfy the strength requirements given for side doors in this Section. They are to be effectively closed and secured watertight before the ship leaves port, and are to be kept closed during navigation. Such ports are not to have their lowest point below the deepest subdivision Load Line.

(b) Where the inboard end of a rubbish chute is below the margin line in a passenger ship, the inboard end cover is to be watertight and, in addition to the discharge flap interlock, a screwdown automatic non-return valve is to be fitted in an easily accessible position above the deepest subdivision. The valve is to be controlled from a position above the bulkhead deck and provided with an open/shut indicator, and kept closed when not in use. A suitable notice is to be displayed at the valve position.

*8.2.9* For ships complying with the requirements of this Section, the securing, supporting and locking devices are defined as follows:

(a) A securing device is used to keep the door closed by preventing it from rotating about its hinges or other pivoted attachments to the ship.

(b) A supporting device is used to transmit external and internal loads from the door to a securing device and from the securing device to the ship's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device, that transmits loads from the door to the ship's structure.

(c) A locking device locks a securing device in the closed position.

*8.2.10* Ro-ro cargo spaces are spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the ship, in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

*8.2.11* Special category spaces are those enclosed spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access, and which may be accommodated on more than one deck where total overall clear height for vehicles does not exceed 10 m.

## 8.3 Scantlings

*8.3.1* In general the strength of side and stern doors is to be equivalent to the strength of the surrounding structure.

*8.3.2* Door openings in the side shell are to have well rounded corners and adequate compensation is to be arranged with web frames at sides and stringers or equivalent above and below, *see* Pt 4, Ch 1,5.

*8.3.3* Doors are to be adequately stiffened, and means are to be provided to prevent movement of the doors when closed. Adequate strength is to be provided in the connections of the lifting/manoeuvring arms and hinges to the door structure and to the ship structure.

*8.3.4* The thickness of the door plating is to be not less than the shell plating calculated with the door stiffener spacing, and in no case to be less than the minimum adjacent shell thickness.

*8.3.5* Where stern doors are protected against direct wave impact by a permanent external ramp, the thickness of the stern door plating may be reduced by 20 per cent relative to the requirements of 8.3.4. Those parts of the stern door which are not protected by the ramp are to have the thickness of plating in full compliance with 8.3.4.

*8.3.6* Where higher tensile steel is proposed, the plating thickness required in 8.3.4 and 8.3.5 may be reduced by $\sqrt{k}$.

*8.3.7* The section modulus of horizontal or vertical stiffeners is to be not less than required for the adjacent shell framing using the actual stiffener spacing. Consideration is to be given, where necessary, to differences in fixity between ship's frames and door stiffeners.

*8.3.8* Where necessary, door secondary stiffeners are to be supported by primary members constituting the main stiffening elements of the door.

*8.3.9* The scantlings of such primary members are to be based on direct strength calculations. Normally, formulae for simple beam theory may be applied to determine the bending stress. Members are to be considered to have simply supported end connections. The design load is the uniformly distributed external sea pressure, $p_e$, as defined in 8.8.1. For minimum scantlings, $p_e$, is to be taken as 25 kN/m$^2$ (2,55 tonne-f/m$^2$) and the permissible stresses as follows:

$$\tau = \frac{80}{k} \text{ N/mm}^2 \quad \left(\frac{8,2}{k} \text{ kgf/mm}^2\right)$$

$$\sigma = \frac{120}{k} \text{ N/mm}^2 \quad \left(\frac{12,2}{k} \text{ kgf/mm}^2\right)$$

$$\sigma_e = \frac{150}{k} \text{ N/mm}^2 \quad \left(\frac{15,3}{k} \text{ kgf/mm}^2\right)$$

*8.3.10* The webs of primary members are to be adequately stiffened, preferably in a direction perpendicular to the shell plating.

*8.3.11* The stiffness of the edges of the doors and the hull structure in way are to be sufficient to ensure weathertight integrity. Edge stiffeners/girders are to be adequately stiffened against rotation and are to have a moment of inertia not less than:

$$I = 0,8 p_I d^4 \text{ cm}^4$$
$$(I = 8 p_I d^4 \text{ cm}^4)$$

where

$p_I$ = packing line pressure along edges, not to be taken less than 50 N/cm (5,1 kgf/cm).

For edge girders supporting main door girders between securing devices, the moment of inertia is to be increased in relation to the additional force.

*8.3.12* The buckling strength of primary members is to be specially considered.

*8.3.13* All load transmitting elements in the design load path from door through securing and supporting devices into the ship structure, including welded connections, are to be to the same strength standard as required for the securing and supporting devices. These elements include pins, supporting brackets and back-up brackets. Where cut-outs are made in the supporting structure, the strength and stiffness will be specially considered.

## 8.4 Doors serving as ramps

*8.4.1* Where doors also serve as vehicle ramps, the plating and stiffeners are to be not less than required for vehicle decks, *see* Ch 9,3.

*8.4.2* The design of the hinges for these doors should take into account the ship angle of trim or heel which may result in uneven loading of the hinges.

### 8.5 Arrangements for the closing, securing and supporting of doors

*8.5.1* Doors are to be fitted with adequate means of closing, securing and support so as to be commensurate with the strength and stiffness of the surrounding structure. The hull supporting structure in way of the doors is to be suitable for the same design loads and design stresses as the securing and supporting devices. Where packing is required, the packing material is to be of comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing may be considered. Maximum design clearance between securing and supporting devices is generally not to exceed 3 mm.

*8.5.2* Devices are to be simple to operate and easily accessible. They are to be of a design approved by Lloyd's Register for the intended purpose.

*8.5.3* Securing devices are to be equipped with positive locking arrangements. Arrangements are to be such that the securing devices are retained in the closed position within design limits of inclination, vibration and other motion-induced loads and in the event of loss of any actuating power supply.

*8.5.4* Systems for door opening/closing and securing/locking are to be interlocked in such a way that they can only operate in a proper sequence. Hydraulic systems are to comply with Pt 5, Ch 14,9.

*8.5.5* Means are to be provided to enable the doors to be mechanically fixed in the open position taking into account the self weight of the door and a minimum wind pressure of 1,5 kN/m$^2$ (0,153 tonne-f/m$^2$) acting on the maximum projected area in the open position.

*8.5.6* The spacing for cleats or closing devices should not exceed 2,5 m and there should be cleats or closing devices positioned as close to the corners as practicable. Alternative arrangements for ensuring weathertight sealing will be specially considered.

*8.5.7* Control and monitoring arrangements are to comply with the applicable requirements of Pt 6, Ch 2,19.

### 8.6 Design loads

*8.6.1* The design force considered for the scantlings of primary members, securing and supporting devices of side shell doors and stern doors are to be taken not less than:

(a) Design forces for securing or supporting devices of doors opening inwards:

External force:

$P_e = Ap_e + P_p$ kN (tonne-f)

Internal force:

$P_i = P_o + 10W$ kN

($P_i = P_o + 1{,}02W$ tonne-f)

(b) Design forces for securing or supporting devices of doors opening outwards:

External force:

$P_e = Ap_e$ kN (tonne-f)

Internal force:

$P_i = P_o + 10W + P_p$ kN

($P_i = P_o + 1{,}02W + P_p$ tonne-f)

(c) Design forces for primary members:

External force:

$P_e = Ap_e$ kN (tonne-f)

Internal force:

$P_i = P_o + 10W$ kN

($P_i = P_o + 1{,}02W$ tonne-f)

whichever is the greater.

The symbols used are defined as follows:

$p_e$ = external sea pressure, in kN/m$^2$ (tonne-f/m$^2$), determined at the centre of gravity of the door opening and is not to be taken less than:
for $Z_G < T$ $10\,(T - Z_G) + 25$ kN/m$^2$
$(1{,}02\,(T - Z_G) + 2{,}55$ tonne-f/m$^2$)
for $Z_G \geq T$ 25 kN/m$^2$
(2,55 tonne-f/m$^2$)
For stern doors of ships fitted with bow doors, $p_e$ is not to be taken less than:

$p_{emin} = 0{,}6\lambda C_H\,(0{,}8 + 0{,}6L^{0{,}5})^2$ kN/m$^2$

($p_{emin} = 0{,}061\lambda C_H\,(0{,}8 + 0{,}6L^{0{,}5})^2$ tonne-f/m$^2$)

$T$ = summer draught, in metres

$Z_G$ = height of the centre of area of the door, in m, above the base line

$L$ = length of ship, but need not be taken greater than 200 m

$\lambda$ = coefficient depending on the area where the ship is intended to be operated:
= 1 for sea-going ships
= 0,8 for ships operated in coastal waters
= 0,5 for ships operated in sheltered waters

$C_H$ = $0{,}0125L$ for $L < 80$ m
= 1 for $L \geq 80$ m

$A$ = area, in m$^2$, of the door opening

$W$ = weight of the door, in tonnes

$P_p$ = total packing force, kN (tonne-f). When packing is fitted, the packing line force per unit length is to be specified, normally not to be taken less than:
5 kN/m (0,51 tonne-f/m)

$P_o$ = the greater of $P_c$ and $5A$ kN ($0{,}5A$ tonne-f)

$P_c$ = accidental force, in kN (tonne-f), due to loose cargo, etc., to be uniformly distributed over the area $A$ and not to be taken less than 300 kN (30,6 tonne-f). For small doors such as bunker doors and pilot doors, the value of $P_c$ may be taken as zero, provided an additional structure such as an inner ramp is fitted, which is capable of protecting the door from accidental force due to loose cargoes.

### 8.7 Design of securing and supporting devices

*8.7.1* Securing devices and supporting devices are to be designed to withstand the forces given above using the following permissible stresses:

$$\tau = \frac{80}{k} \text{ N/mm}^2 \quad \left(\frac{8,2}{k} \text{ kgf/mm}^2\right)$$

$$\sigma = \frac{120}{k} \text{ N/mm}^2 \quad \left(\frac{12,2}{k} \text{ kgf/mm}^2\right)$$

$$\sigma_e = \frac{150}{k} \text{ N/mm}^2 \quad \left(\frac{15,3}{k} \text{ kgf/mm}^2\right)$$

The terms 'securing device' and 'supporting device' are defined in Pt 4, Ch 2,8.2.8.

*8.7.2* The arrangement of securing and supporting devices is to be such that threaded bolts are not to carry support forces. The maximum tensile stress in way of threads of bolts, not carrying support forces, is not to exceed:

$$\frac{125}{k} \text{ N/mm}^2 \quad \left(\frac{12,7}{k} \text{ kgf/mm}^2\right)$$

*8.7.3* For steel to steel bearings in securing and supporting devices, the normal bearing pressure is not to exceed $0,8\sigma_o$, *see* 8.1.1. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification. The normal bearing pressure is to be calculated by dividing the design force by the projected bearing area.

*8.7.4* The distribution of the reaction forces acting on the securing and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position and stiffness of the supports. Small and/or flexible devices, such as cleats, intended to provide load compression of the packing material are not generally to be included in these calculations.

*8.7.5* Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be considered in the calculation of the reaction forces acting on the devices.

*8.7.6* The number of securing and supporting devices is generally to be the minimum practicable whilst complying with 8.5.3 and taking account of the available space in the hull for adequate support.

*8.7.7* The arrangement of securing devices and supporting devices in way of these securing devices is to be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable of withstanding the reaction forces, without exceeding, by more than 20 per cent, the permissible stresses as defined in 8.7.1.

### 8.8 Operating and Maintenance Manual

*8.8.1* An Operating and Maintenance Manual for the doors is to be provided on board and is to contain necessary information on:

(a) main particulars and design drawings,
(b) service conditions, e.g. service area restrictions, acceptable clearances for supports,
(c) maintenance and function testing,
(d) register of inspections, repairs and renewals.

*8.8.2* For passenger/vehicle ferries and roll on-roll off cargo ships, *see* Pt 4, Ch 2,1.1.1, an Operating and Maintenance Manual for the doors, as defined in Pt 4, Ch 2,8.7.1, is to be provided on board instead of that required by 8.8.1.

*8.8.3* The Manual is to be submitted for approval, and is to contain a note recommending that recorded inspections of the door supporting and securing devices be carried out by the ship's staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of the doors. Any damages recorded during such inspections are to be reported to LR.

*8.8.4* Documented operating procedures for closing and securing the doors are to be kept on board and posted at an appropriate place.

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## ■ *Section 9*
## Watertight doors in bulkheads below the freeboard deck

### 9.1 Openings in bulkheads

*9.1.1* Certain openings below the freeboard deck are permitted, but these must be kept to a minimum and provided with means of closing to watertight standards. All such openings are to be to the satisfaction of the Surveyor.

### 9.2 Watertight doors

*9.2.1* Watertight doors are to be of equivalent strength to the unpierced bulkhead, efficiently constructed and fitted, and are to be capable of being closed watertight when the ship is listed up to 15° either way. They are to be operated under working conditions and hose tested in place, *see* Ch 1,8.3.

*9.2.2* The scantlings of the watertight doors are to comply with Pt 4, Ch 1,9 using the actual stiffener spacing of the door.

*9.2.3* The scantlings of the frames of the watertight doors are to satisfy the requirements of watertight bulkheads given in Table 1.9.1(5) in Pt 4, Ch 1,9 taking into account the arrangement of door stiffeners and securing arrangements.

*9.2.4* Watertight doors of the sliding type are to be capable of being operated both at the door itself and from an accessible position above the bulkhead deck. Means are to be provided at all the remote operating positions to indicate whether the door is open or closed. Doors are to be capable of being remotely closed from the bridge. The relevant regulations regarding openings in watertight bulkheads, contained in the *International Convention for the Safety of Life at Sea, 1974* and applicable amendments, are also to be complied with.

*9.2.5* Hinged watertight doors of approved pattern may be fitted in ‘tween decks in approved positions. The hinges of these doors are to be fitted with gunmetal pins or gunmetal bushes.

*9.2.6* The frames of vertical watertight doors shall have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

*9.2.7* Means are to be provided on the navigating bridge to indicate whether the watertight doors are open or closed. A notice is to be affixed to both sides of each such door or hatch cover to the effect that it is not to be left open.

*9.2.8* In passenger ships the number and construction of the watertight doors in bulkheads will be specially considered. Each watertight door is to be tested, *see* Table 1.8.1 in Chapter 1. The test may be carried out either before or after the door is fitted. The relevant regulations regarding openings in watertight bulkheads in passenger ships, contained in the *International Convention for the Safety of Life at Sea, 1974* and applicable amendments, are also to be complied with.

## ■ *Section 10*

## External openings and openings in watertight bulkheads and internal decks in cargo ships

### 10.1 Shell and watertight subdivision openings

*10.1.1* In addition to the requirements of Sections 8 and 9, for cargo ships of 80 m in length and above, the relevant regulations concerning shell and watertight subdivision openings contained in the *International Convention for the Safety of Life at Sea*, 1974, and amendments thereto are also to be complied with.

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